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Hospital Incinerator Operator Training Course
Volume 2, Presentation Slides

Midwest Research Inst., Cary, NC

Prepared for:

Environmental Protection Agency, Research Triangle Park, NC

Mar 89

U.S. Department of Commerce
National Technical Information Service
NTIS

PB89-189880

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EPA Hospital Incinerator Operator Training Course Volume II

Presentation Slides

Control Technology Center

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U.S. DEPARTMENT OF COMMERCE
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EPA-450/3-89-004

HOSPITAL INCINERATOR OPERATOR TRAINING COURSE:

VOLUME II

PRESENTATION SLIDES

CONTROL TECHNOLOGY CENTER

SPONSORED BY:

Emission Standards Division
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

Air and Energy Engineering Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

Center for Environmental Research Information
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, OH 45268

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HOSPITAL INCINERATOR OPERATOR TRAINING COURSE:
VOLUME II
PRESENTATION SLIDES

EPA Contract No. 68-02-4395
Work Assignment 16

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Control Technology Center
U. S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

NOTICE

This training course is intended to provide the operator with a basic understanding of the principles of incineration and air pollution control. This training course is not a substitute for site-specific hands-on training of the operator with the specific equipment to be operated.

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James Eddinger, Office of Air Quality Planning and Standards
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16. ABSTRACT

This document is Volume II of a three-volume training course for operators of hospital waste incinerators. Volume I is the Student Handbook (EPA 450/3-89-003), and Volume III is the Instructor Handbook (EPA 450/3-89-010). This training course was originally prepared by the Control Technology Center for the State of Maryland. The purpose of this course is to provide hospital waste incinerator operators with a basic understanding of the principles of incineration and air pollution control and to identify, generally, good operation and maintenance (O&M) practices. Proper O&M, in addition to reducing air emissions, improves equipment reliability and performance, prolongs equipment life, and helps to ensure proper ash burnout. The course is not intended to replace site-specific, hands-on training of operators with the specific equipment to be operated.

Volume II contains classroom materials including a copy of the presentation slides so that students can follow along during the class and worksheets that can be completed during the classroom sessions. The course includes 11 separate classroom sessions covering topics such as basic combustion principles and incinerator design; air pollution control equipment design, function, operation, and monitoring; incinerator operation; maintenance inspections; typical problems; and State regulations.

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DISCLAIMER

This document generally describes the proper operation of a hospital waste incinerator. It is based on EPA's review and assessment of various scientific and technical sources. The EPA does not represent that this document comprehensively sets forth procedures for incinerator operation, or that it describes applicable legal requirements, which vary according to an incinerator's location. Proper operation of an incinerator is the responsibility of the owner and operator.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ACKNOWLEDGEMENT

This document was prepared by Midwest Research Institute located in Cary, North Carolina. Principal authors were Roy Neulicht and Linda Chaput; Dennis Wallace, Mark Turner, and Stacy Smith were contributing authors. Participating on the project team for the EPA were Ken Durkee and James Eddinger of the Office of Air Quality Planning and Standards, Charles Masser of Air and Energy Engineering Research Laboratory, James Topsale of Region III, Charles Pratt of the Air Pollution Training Institute, and Justice Manning of the Center for Environmental Research Information. Also participating on the project team were Carl York and William Paul of the Maryland Air Management Administration.

Numerous persons were very helpful throughout this project and provided information and comments for these course materials. Listed below are some who deserve special acknowledgement for their assistance.

- Mr. Larry Doucet, Doucet and Mainka, who provided a thorough review of the student handbook.

- The following persons and facilities who provided our staff access to their facilities:

  Messrs. Steve Shuler and Greg Swan, Joy Energy Systems; William Tice, Rex Hospital; Dean Clark, Bio-Medical Services, Inc.; Gary Kamp, Presbyterian--University Medical Center; Don Rust, Duke University Medical Center; Chip Priester, Southland Exchange Joint Venture; and Gregory Price, The Johns Hopkins Hospital.

- The following manufacturers who provided us with detailed operating and maintenance information:

  Joy Energy Systems, John Zink Company, Cleaver Brooks, and Industronics.

- Mr. Charles Bollack and his staff, Mercy Medical Center, who hosted the first trial run of this course and Mr. Robert J. Winterbottom, R. J. Winterbottom, Inc., who assisted during the course at Mercy Medical Center.

PREFACE

The program for development of a training course for operators of hospital medical waste incinerators was funded as a project of EPA's Control Technology Center (CTC).

The CTC was established by EPA's Office of Research and Development (ORD) and Office of Air Quality Planning and Standards (OAQPS) to provide technical assistance to State and local air pollution control agencies. Three levels of assistance can be accessed through the CTC. First, a CTC HOTLINE has been established to provide telephone assistance on matters relating to air pollution control technology. Second, more in-depth engineering assistance can be provided when appropriate. Third, the CTC can provide technical guidance through publication of technical guidance documents, development of personal computer software, and presentation of workshops on control technology matters. The technical guidance projects, such as this one to develop training materials for hospital waste incinerator operators, focus on topics of national or regional interest that are identified through contact with State and local agencies.

The CTC became interested in developing a basic training course for operators of hospital waste incinerators with the idea that properly trained operators can improve operating and maintenance procedures and, consequently, minimize air emissions. This training course was prepared to provide the operator with a basic understanding of the principles of incineration and air pollution control and to identify, in a general sense, good operating practices. The course is not intended as a substitute for site-specific hands-on training of the operator with the specific equipment to be operated.

The course consists of three volumes:

Volume I--Student Handbook
Volume II--Course Presentation Slides
Volume III--Instructor Handbook

This volume contains the classroom materials including a copy of the presentation slides and student worksheets. A copy of the presentation slides is provided in Part I so that you can easily follow along during the class. You may want to make notes on the slides to remind yourself later of important points brought up by the instructor or other students. Several worksheets also are included in Part II. Your instructor will allow time for you to complete these worksheets during class.

CONTENTS

PART I: COURSE SLIDES

COURSE INTRODUCTION

SESSION 1. PROTECTING THE ENVIRONMENT - YOUR RESPONSIBILITY

SESSION 2. BASIC COMBUSTION PRINCIPLES

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SESSION 4. AIR POLLUTION CONTROL EQUIPMENT DESIGN AND FUNCTIONS

SESSION 5. MONITORING AND AUTOMATIC CONTROL SYSTEMS

SESSION 6. INCINERATOR OPERATION

SESSION 7. AIR POLLUTION CONTROL SYSTEMS OPERATION

SESSION 8. MAINTENANCE INSPECTION--A NECESSARY PART OF YOUR JOB

SESSION 9. TYPICAL PROBLEMS

SESSION 10. STATE REGULATIONS

SESSION 11. SAFETY: AN IMPORTANT PART OF YOUR JOB

LIST OF SOURCES FOR DRAWINGS

PART II: CLASSROOM WORKSHEETS

1. INCINERATOR SYSTEM INFORMATION
2. INCINERATOR SYSTEM INFORMATION
3. INCINERATOR SYSTEM INFORMATION
4. OPERATING REVIEW
5. OPERATING PROBLEMS REVIEW
6. INCINERATOR SYSTEM INFORMATION
7. SAFETY REVIEW

PART I. SLIDE PRESENTATION

This section presents the slides and worksheets which will be used during the classroom portion of the course. The slides are organized by session. The slides presented here will be supplemented with actual photographs (which are not presented in this hand-out) during the presentation. Some drawings have been taken from other documents; the sources for these drawings are listed at the end of this part.

COURSE GOALS

TO PROVIDE YOU WITH AN UNDERSTANDING OF:

-- BASIC PRINCIPLES OF INCINERATION
-- PROPER OPERATION AND MAINTENANCE PRACTICES
-- REGULATORY REQUIREMENTS AND SAFETY CONCERNS

UPON COMPLETING THIS COURSE YOU SHOULD:

- UNDERSTAND AIR POLLUTION PROBLEMS AND HOW TO MINIMIZE THEM
- UNDERSTAND THE CAUSE OF COMMON OPERATING PROBLEMS AND SAFETY HAZARDS AND HOW TO MINIMIZE THEM
- KNOW HOW TO MONITOR OPERATION TO AID IN COMPLYING WITH REGULATORY REQUIREMENTS

SESSION 1.

PROTECTING THE ENVIRONMENT - YOUR RESPONSIBILITY

SLIDE 1-1

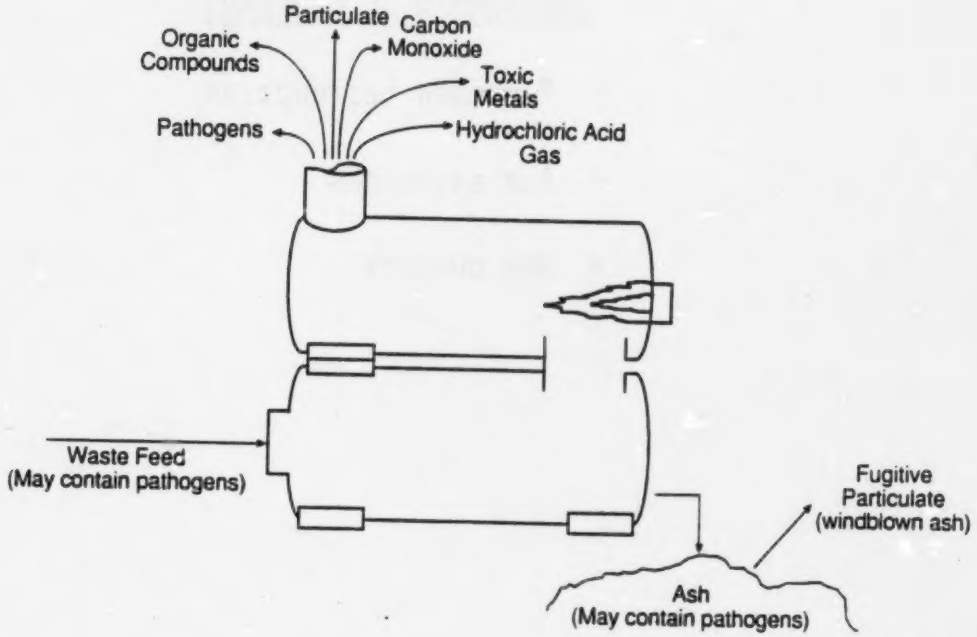
WHY INCINERATE?

- REDUCES WEIGHT AND VOLUME OF WASTE
- STERILIZES THE WASTE
- DESTROYS ORGANIC MATERIALS THAT MAY DEGRADE AND PRODUCE HARMFUL BY-PRODUCTS IN LANDFILLS
- AESTHETIC REASONS--DESTROYS WASTES SUCH AS BODY PARTS THAT PUBLIC FINDS OBJECTIONABLE

SLIDE 1-2

ENVIRONMENTAL CONCERNS

- PATHOGEN DESTRUCTION
- AIR EMISSIONS
- ASH QUALITY


Particulate
Carbon Monoxide
Organic Compounds
Toxic Metals
Pathogens
Hydrochloric Acid Gas
Waste Feed (May contain pathogens)
Fugitive Particulate (windblown ash)
Ash (May contain pathogens)

ENVIRONMENTAL CONCERNS

SLIDE 1-4

THE OPERATOR--YOUR ROLE

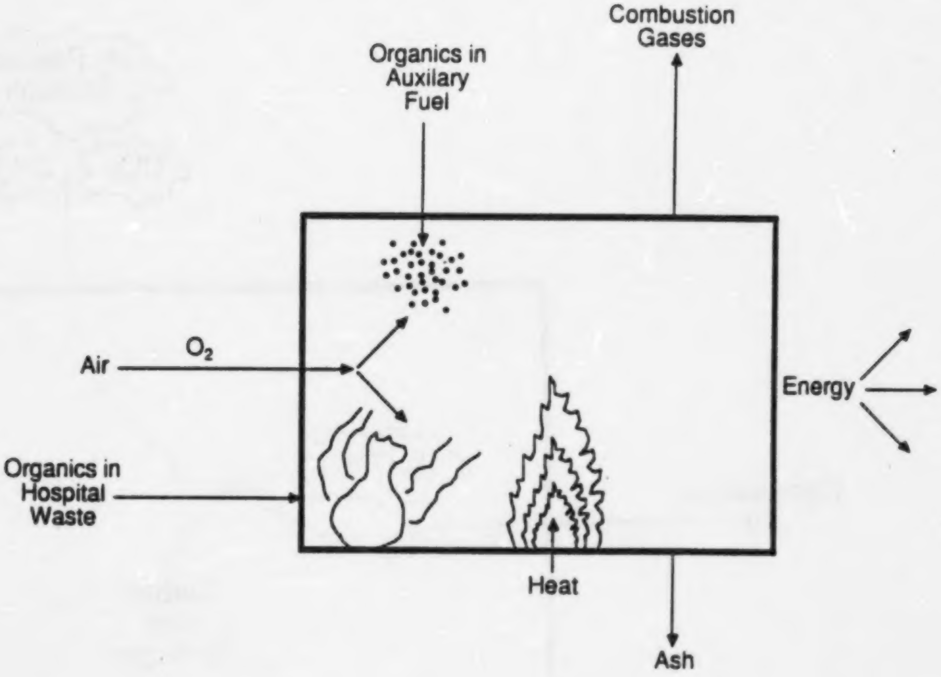
IT IS YOUR ROLE AND RESPONSIBILITY TO PROTECT THE ENVIRONMENT BY:

- MINIMIZING POLLUTANT EMISSIONS THROUGH PROPER OPERATION
- MAINTAINING ACCEPTABLE ASH QUALITY THROUGH PROPER OPERATION
- PREVENTING PARTICULATE EMISSIONS FROM ASH HANDLING AND STORAGE
- IDENTIFYING MAINTENANCE PROBLEMS BY PERFORMING REGULAR INSPECTIONS

SESSION 2.

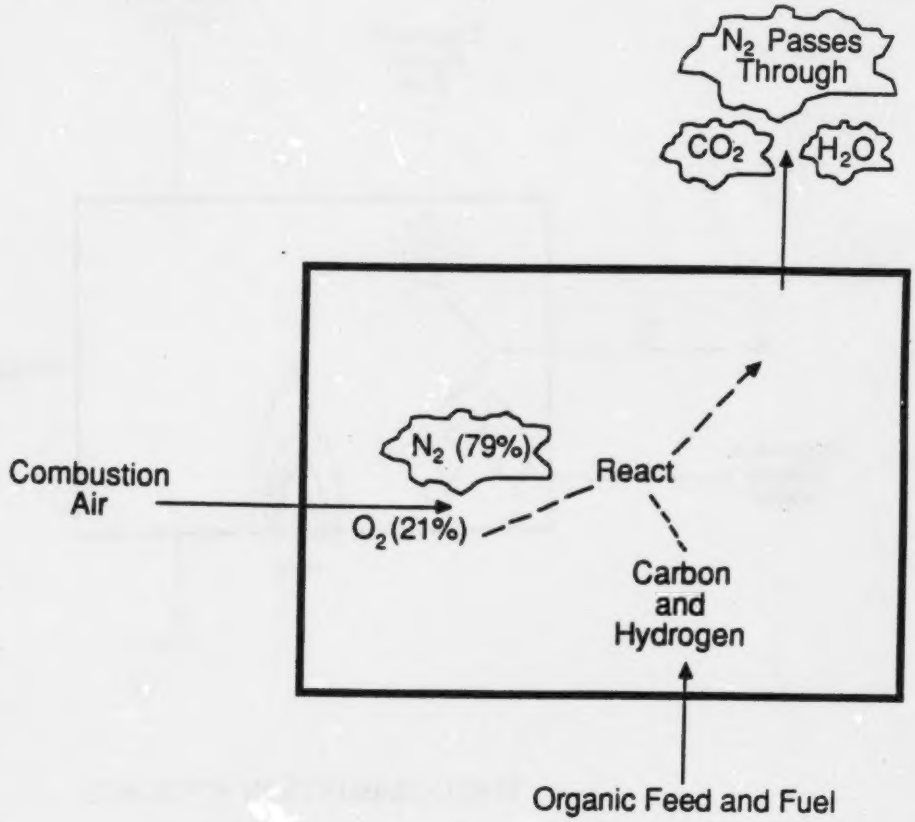
BASIC COMBUSTION PRINCIPLES

SLIDE 2-1


Combustion Gases
Organics in Auxilary Fuel
Air
O_2
Energy
Organics in Hospital Waste
Heat
Ash

THE COMBUSTION PROCESS

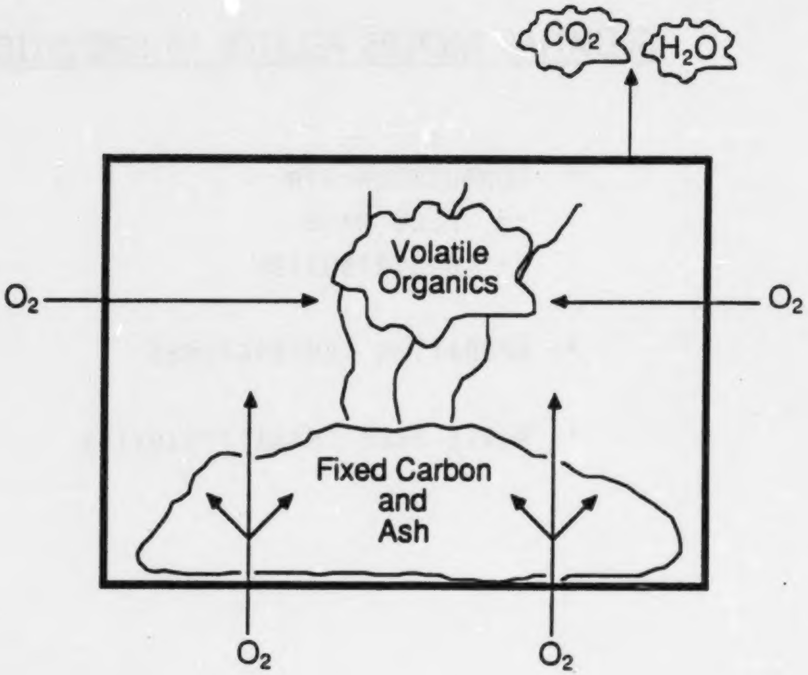
Slide 2-2



N_2 Passes Through
CO_2
H_2O
N_2 (79%)
Combustion Air
React
O_2 (21%)
Carbon and Hydrogen
Organic Feed and Fuel

FATE OF COMBUSTION AIR

SLIDE 2-3


CO_2
H_2O
Volatile Organics
O_2
O_2
Fixed Carbon and Ash
O_2
O_2

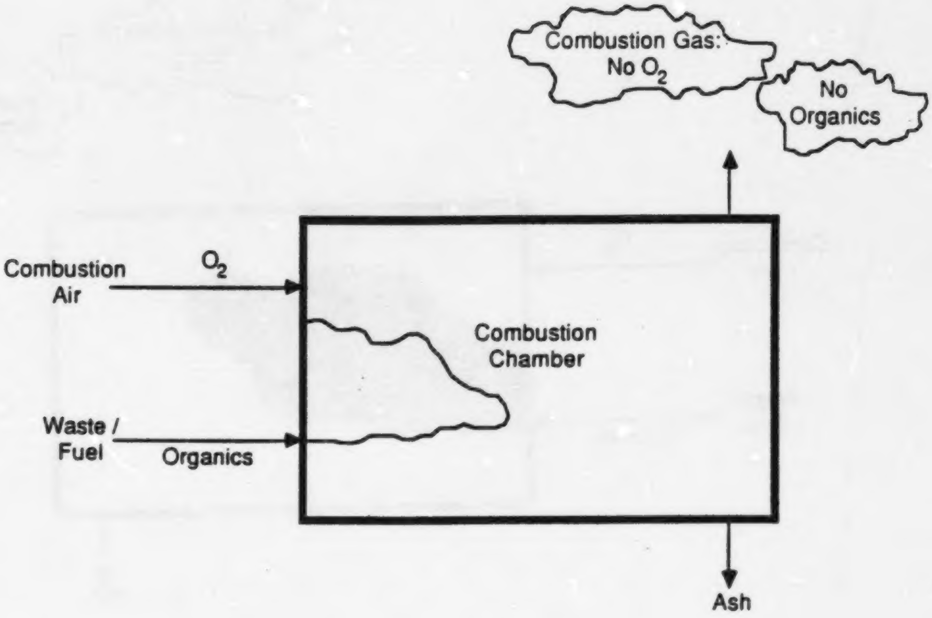
OXYGEN REACTION

SLIDE 2-4

OPERATING FACTORS RELATED TO COMBUSTION

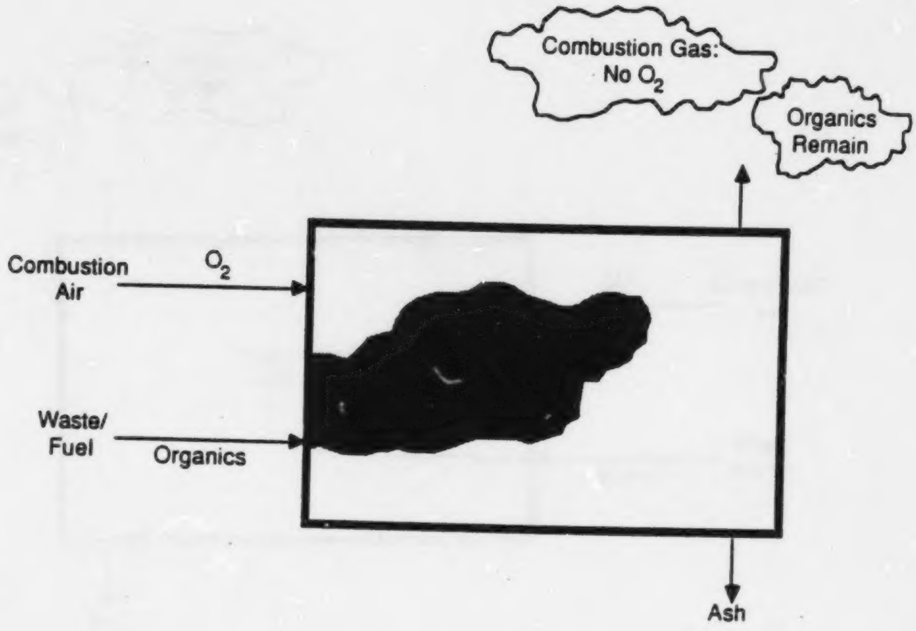
- COMBUSTION AIR
  - FLOW RATE
  - DISTRIBUTION
- OPERATING TEMPERATURES
- WASTE FEED CHARACTERISTICS

Slide 2-5


Combustion Gas:
No O_2
No
Organics
Combustion
Air
O_2
Combustion
Chamber
Waste /
Fuel
Organics
Ash

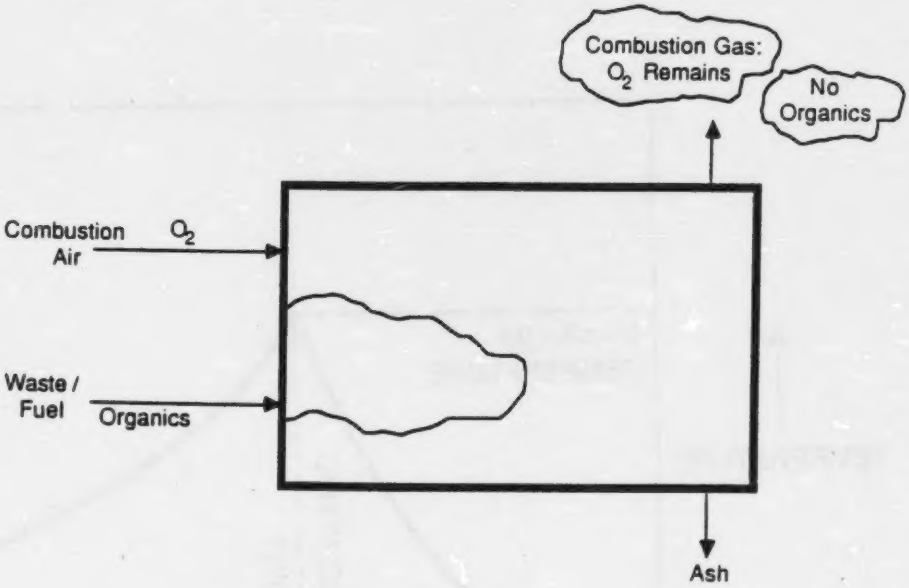
STOICHIOMETRIC AIR LEVEL

SLIDE 2-6


Combustion Gas:
No O_2
Organics
Remain
Combustion
Air
O_2
Waste/
Fuel
Organics
Ash

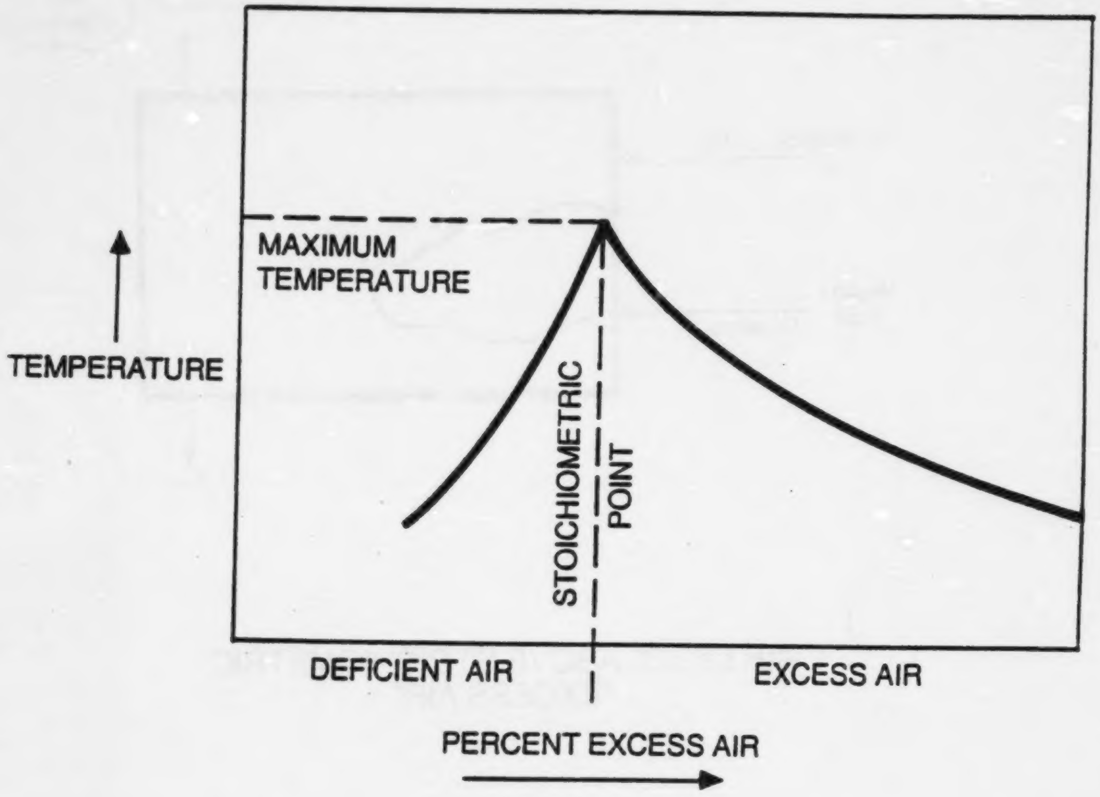
AIR LEVEL BELOW STOICHIOMETRIC
"STARVED-AIR"

SLIDE 2-7


Combustion Gas:
O_2 Remains
No
Organics
Combustion
Air
O_2
Waste /
Fuel
Organics
Ash

AIR LEVEL ABOVE STOICHIOMETRIC
"EXCESS AIR"

SLIDE 2-8



CONTROL OF TEMPERATURE AS A FUNCTION OF EXCESS AIR[1]

SLIDE 2-9

HOSPITAL WASTE CHARACTERISTICS

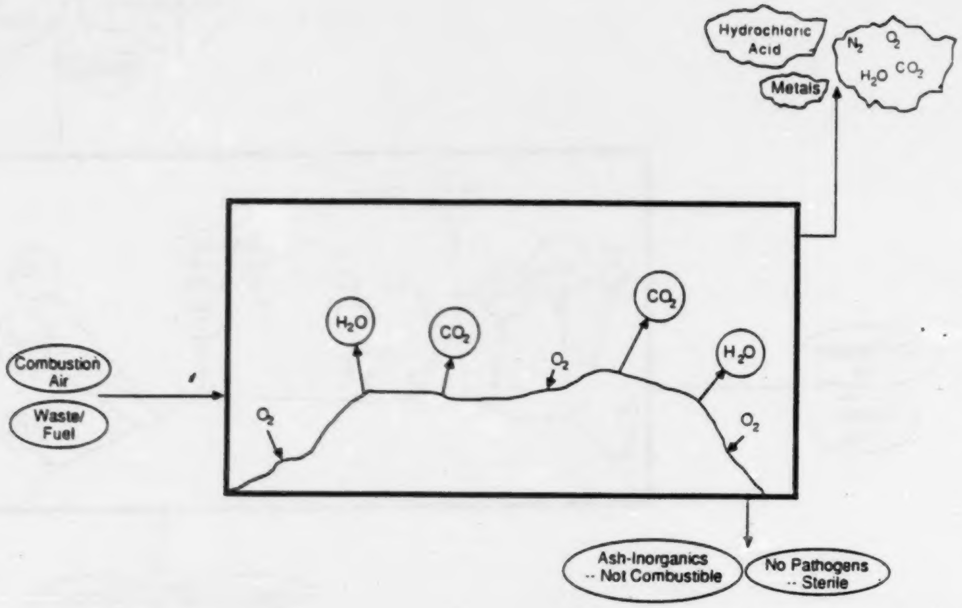
WASTE TYPE	HIGH HEAT VALUE, BTU/LB	MOISTURE, %	HEAT VALUE AS-FIRED, BTU/LB
GAUZE, PADS, SWABS, GARMENTS, PAPER	8,000-12,000	0-30	5,600-12,000
PLASTICS	9,700-20,000	0-1	9,600-20,000
HUMAN ANATOMICAL	8,000-12,000	70-90	800-3,600

Slide 2-10

KEY OPERATING PARAMETERS

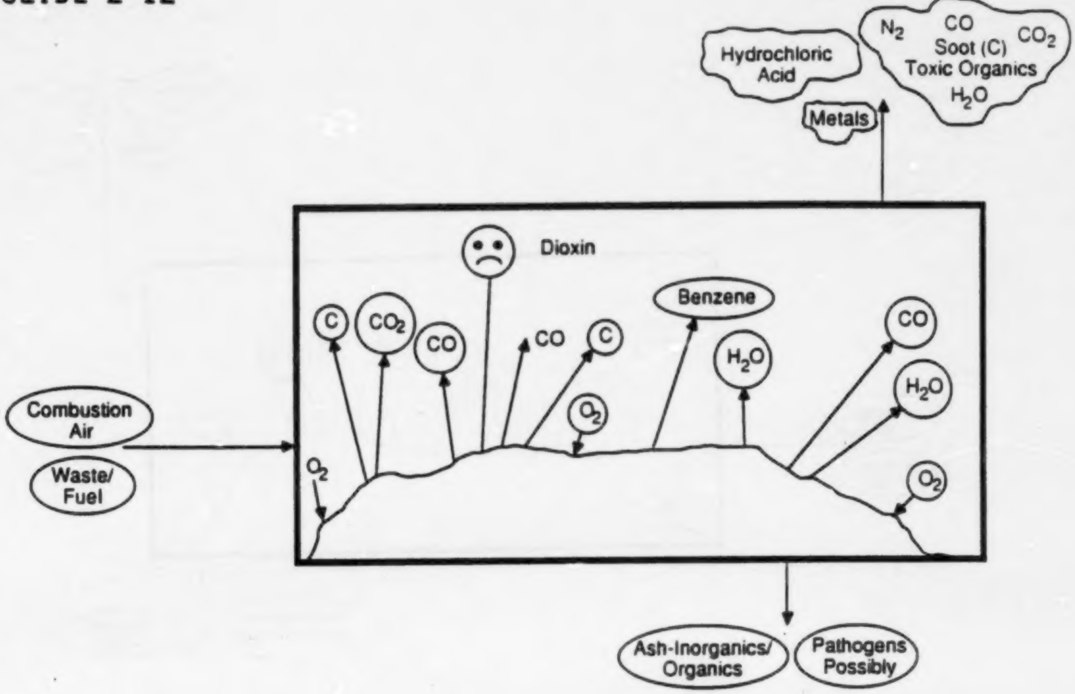
- Combustion air
- Mixing
- Temperature
- Residence time/retention time
- Waste characteristics
  - Heating value
  - Moisture content
  - Chlorine content

SLIDE 2-11


Hydrochloric Acid
Metals
N_2
O_2
H_2O
CO_2
Combustion Air
Waste/ Fuel
H_2O
CO_2
CO_2
O_2
H_2O
O_2
O_2
Ash-Inorganics -- Not Combustible
No Pathogens -- Sterile

COMPLETE COMBUSTION

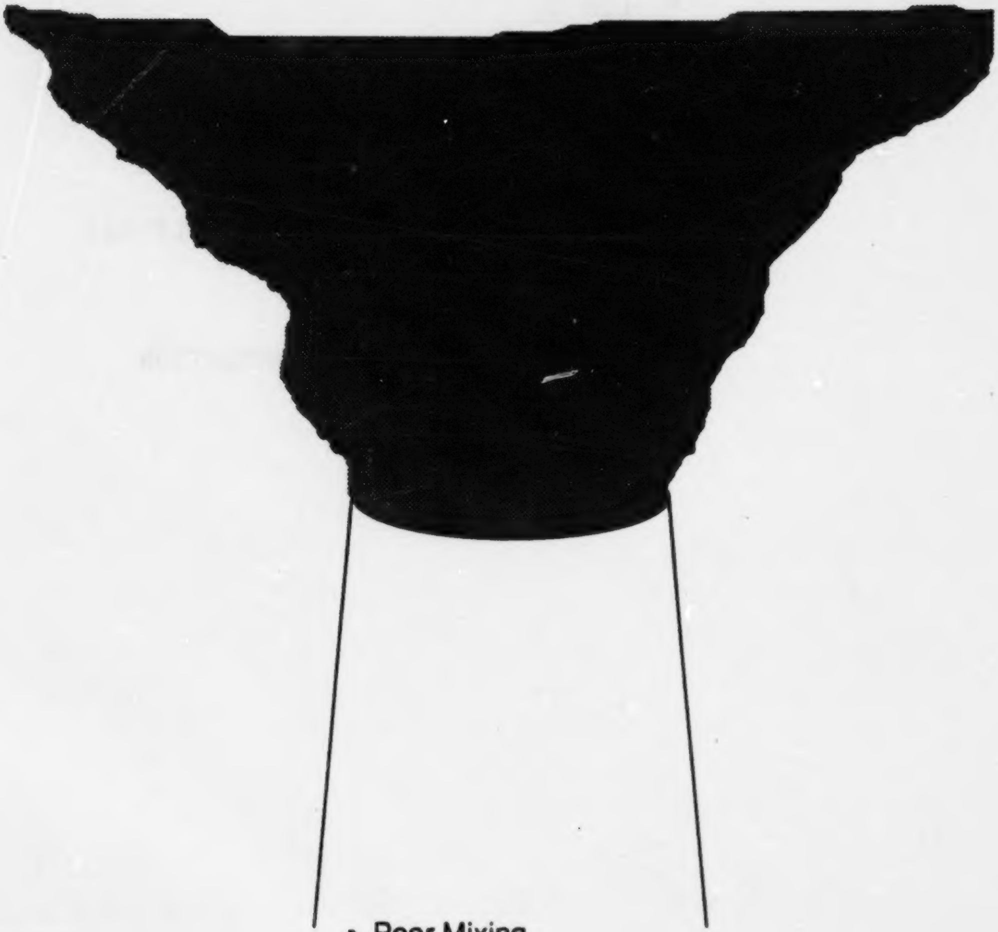
SLIDE 2-12


Hydrochloric Acid
N_2
CO
Soot (C)
CO_2
Toxic Organics
H_2O
Metals
Dioxin
Benzene
C
CO_2
CO
CO
C
O_2
H_2O
CO
H_2O
Combustion Air
Waste/ Fuel
O_2
O_2
Ash-Inorganics/ Organics
Pathogens Possibly

INCOMPLETE COMBUSTION

SLIDE 2-13

OPACITY



- Poor Mixing
- Starved-Air Conditions
- Low Temperatures
- Acid Gases

Slide 2-14

STACK GAS O_2 AND CO

- Low O_2
  -- INSUFFICIENT AIR

- High O_2
  -- TOO MUCH EXCESS AIR COOLS GAS

- High CO means poor combustion

Slide 2-15

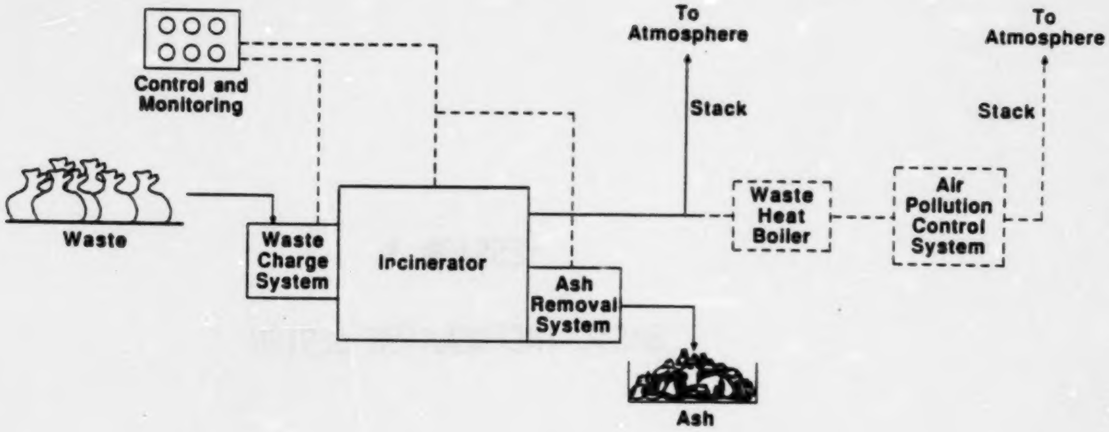
ASH QUALITY

- Visual appearance
- No recognizable medical wastes
- Burnout--carbon remaining
  -- whitish gray vs black

SESSION 3.

BASIC INCINERATOR DESIGN

SLIDE 3-1


Control and Monitoring
To Atmosphere
Stack
To Atmosphere
Stack
Waste
Waste Charge System
Incinerator
Ash Removal System
Waste Heat Boiler
Air Pollution Control System
Ash

MAJOR COMPONENTS OF AN INCINERATION SYSTEM

SLIDE 3-2

INCINERATOR TYPES

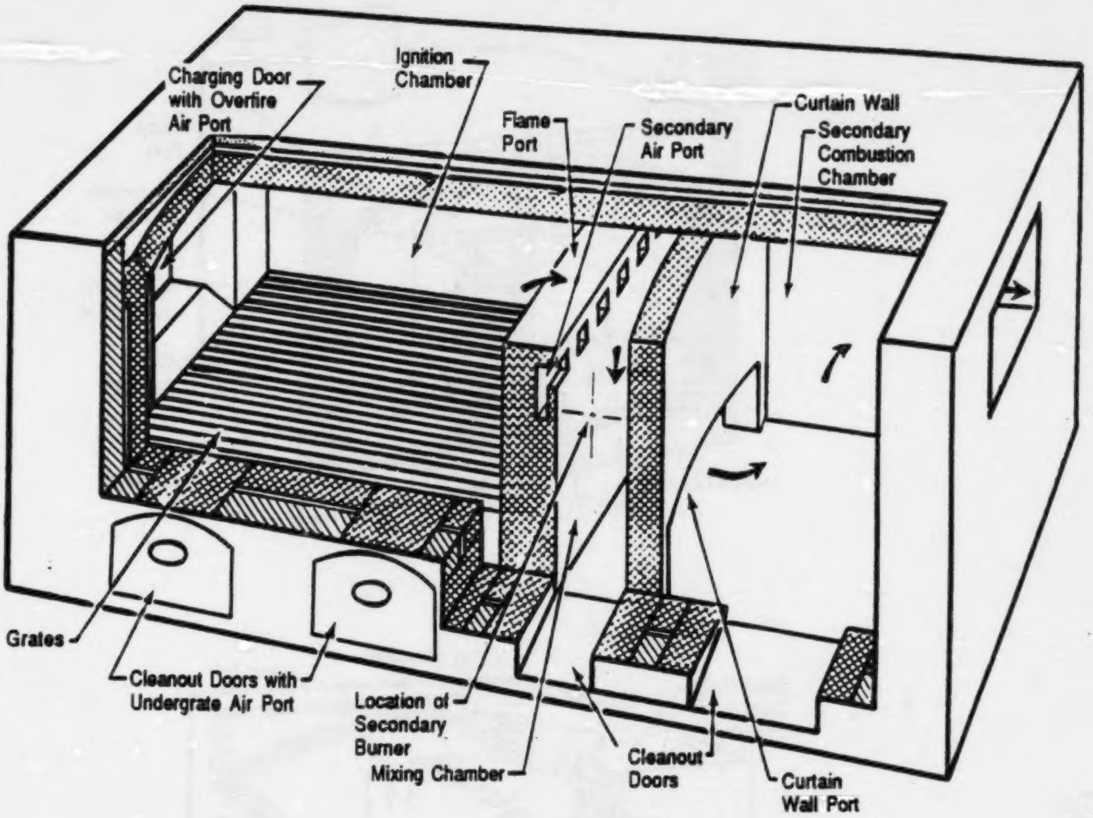
- MULTIPLE CHAMBER--EXCESS AIR
- CONTROLLED (STARVED) AIR
- ROTARY KILN

SLIDE 3-3

MULTIPLE-CHAMBER INCINERATORS

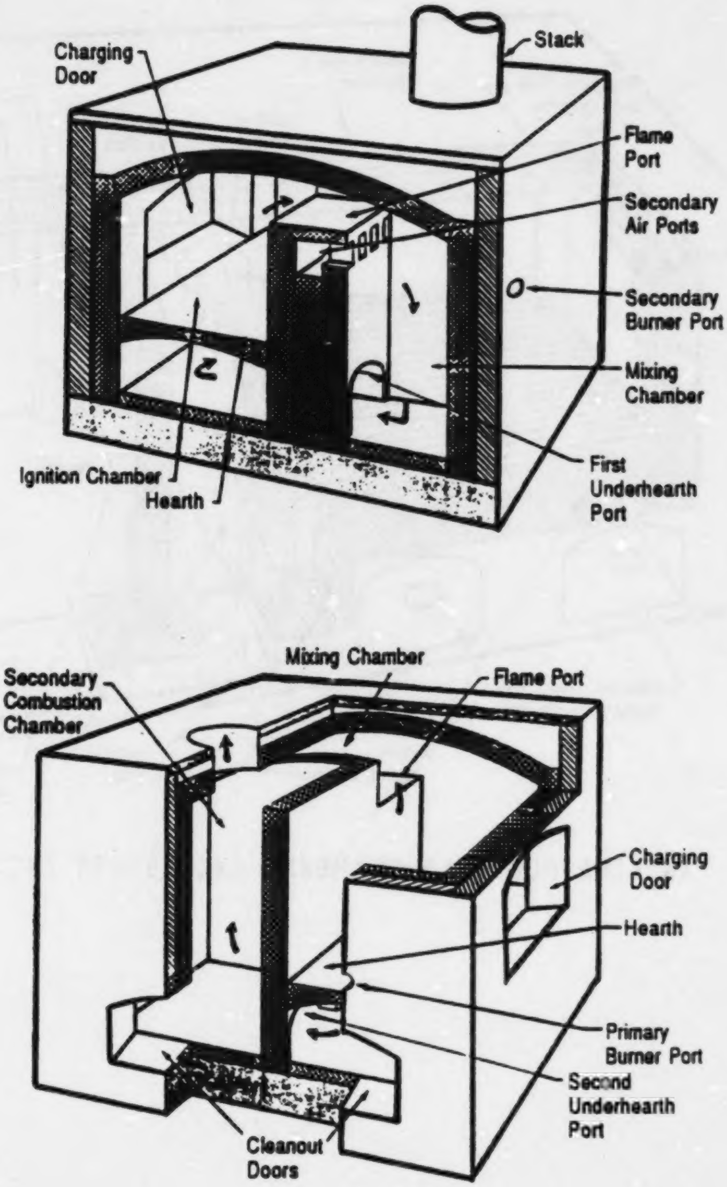
- COMBUSTION OCCURS IN TWO OR MORE CHAMBERS
- PRIMARY AND SECONDARY CHAMBER OPERATE WITH AIR LEVELS ABOVE STOICHIOMETRIC
- PRIMARILY USE OVERFIRE COMBUSTION AIR
- IN-LINE AND RETORT DESIGNS

SLIDE 3-4


Ignition Chamber
Charging Door with Overfire Air Port
Flame Port
Secondary Air Port
Curtain Wall
Secondary Combustion Chamber
Grates
Cleanout Doors with Undergrate Air Port
Location of Secondary Burner
Mixing Chamber
Cleanout Doors
Curtain Wall Port

IN-LINE MULTIPLE-CHAMBER, EXCESS-AIR INCINERATOR[1]

SLIDE 3-5


Charging Door
Stack
Flame Port
Secondary Air Ports
Secondary Burner Port
Mixing Chamber
First Underhearth Port
Ignition Chamber
Hearth
Secondary Combustion Chamber
Mixing Chamber
Flame Port
Charging Door
Hearth
Primary Burner Port
Second Underhearth Port
Cleanout Doors

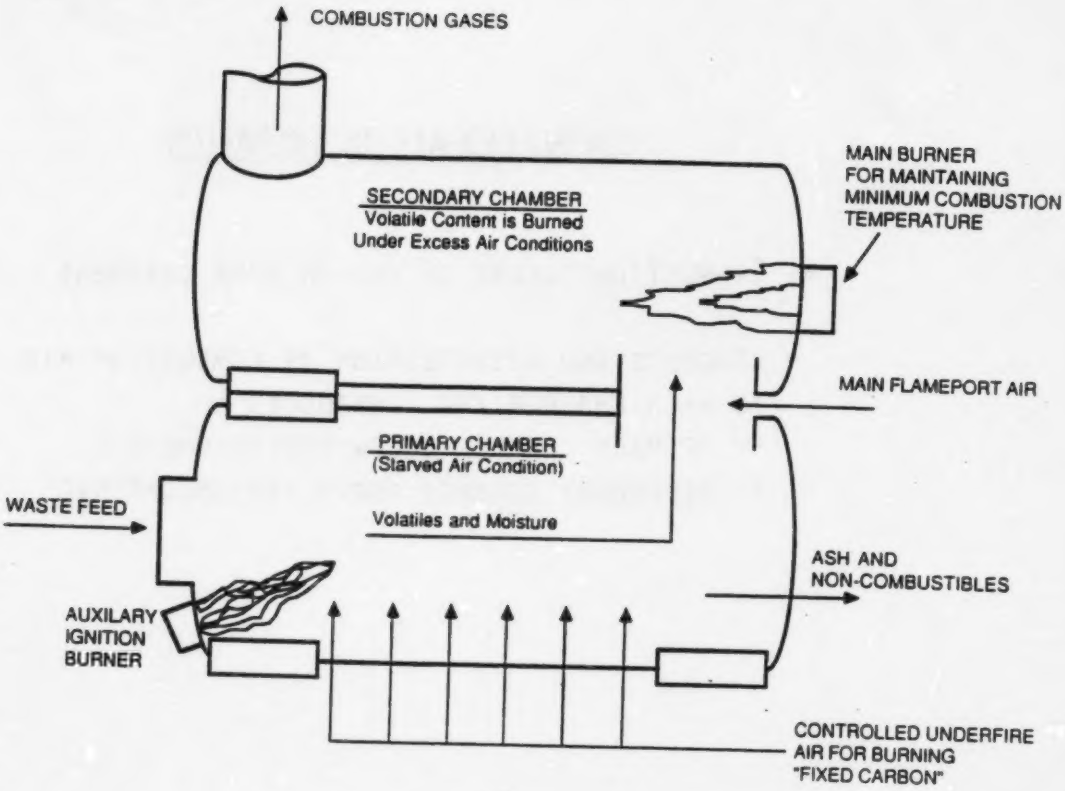
RETORT MULTIPLE-CHAMBER, EXCESS-AIR INCINERATOR [1]

SLIDE 3-6

CONTROLLED-AIR INCINERATION

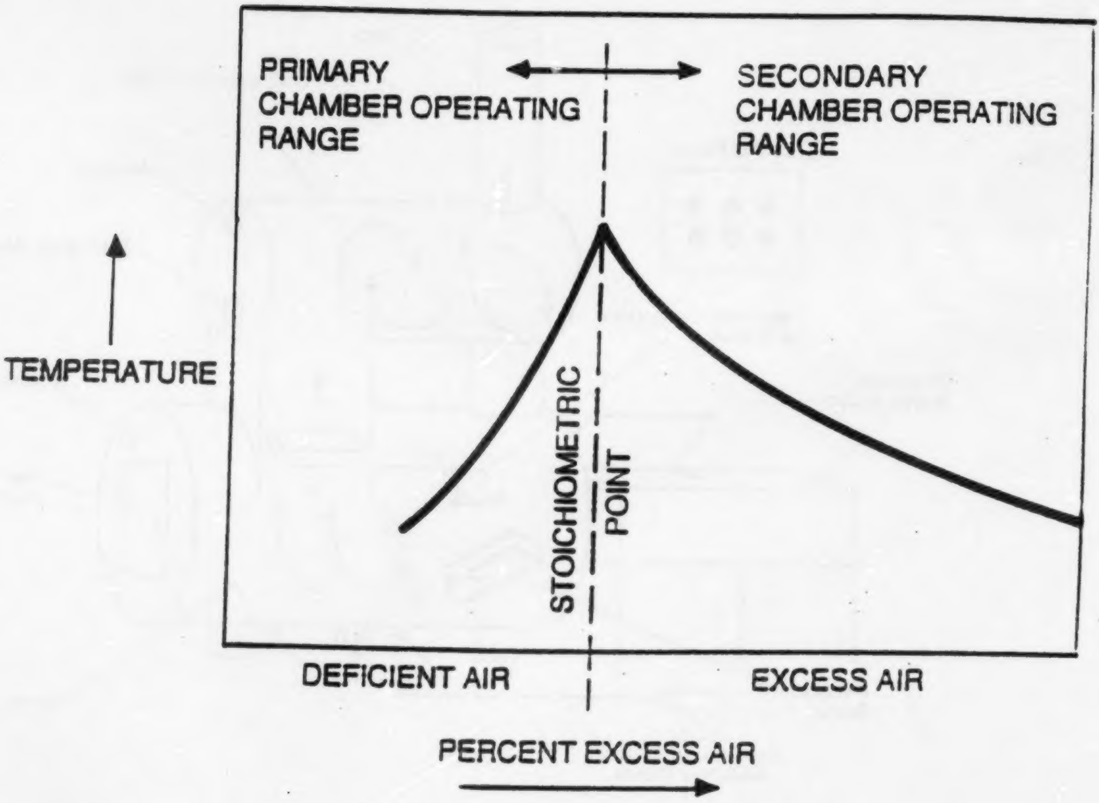
- COMBUSTION OCCURS IN TWO OR MORE CHAMBERS
- AMOUNTS AND DISTRIBUTION OF COMBUSTION AIR TO EACH CHAMBER ARE CONTROLLED
  -- PRIMARY CHAMBER BELOW STOICHIOMETRIC
  -- SECONDARY CHAMBER ABOVE STOICHIOMETRIC

SLIDE 3-7


COMBUSTION GASES
MAIN BURNER FOR MAINTAINING MINIMUM COMBUSTION TEMPERATURE
SECONDARY CHAMBER
Volatile Content is Burned Under Excess Air Conditions
MAIN FLAMEPORT AIR
PRIMARY CHAMBER
(Starved Air Condition)
WASTE FEED
Volatiles and Moisture
ASH AND NON-COMBUSTIBLES
AUXILARY IGNITION BURNER
CONTROLLED UNDERFIRE AIR FOR BURNING "FIXED CARBON"

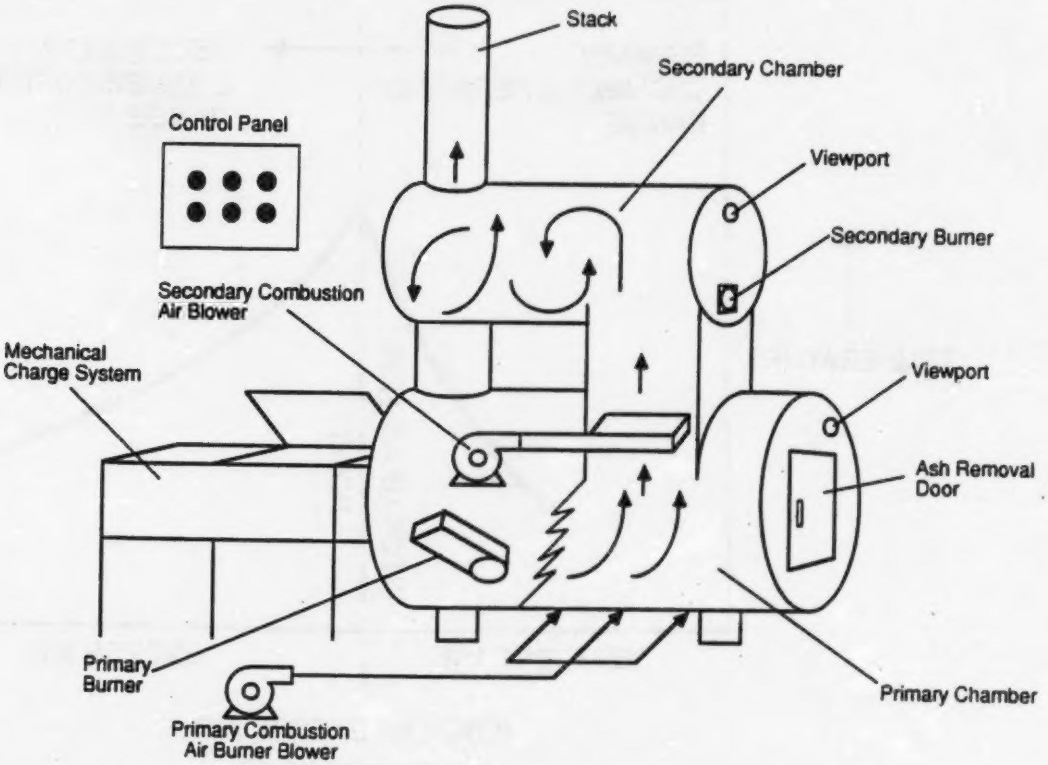
PRINCIPLE OF CONTROLLED-AIR INCINERATION [2]

SLIDE 3-8



CONTROL OF TEMPERATURE AS A FUNCTION OF EXCESS AIR [3]

Slide 3-9


Stack
Secondary Chamber
Control Panel
Viewport
Secondary Burner
Secondary Combustion Air Blower
Mechanical Charge System
Viewport
Ash Removal Door
Primary Burner
Primary Chamber
Primary Combustion Air Burner Blower

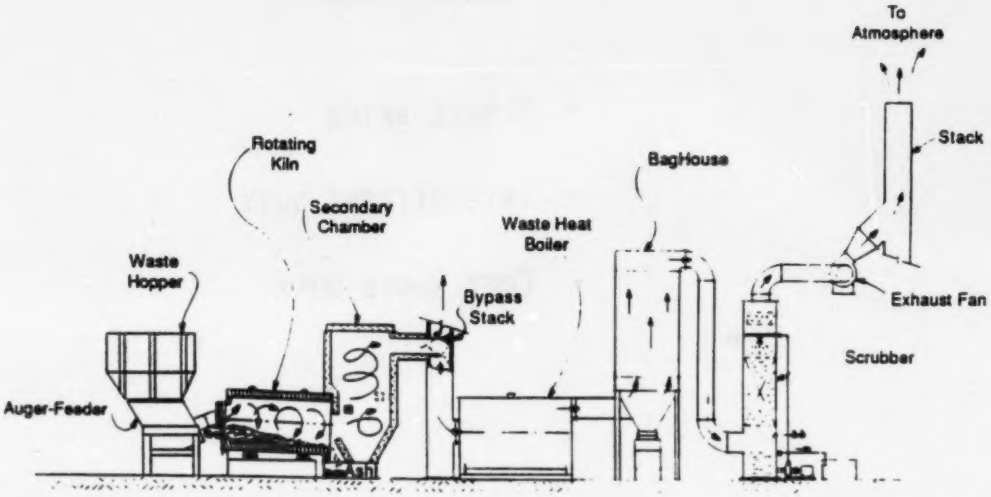
MAJOR COMPONENTS OF A CONTROLLED-AIR INCINERATOR

SLIDE 3-10

ROTARY KILNS

- COMBUSTION OCCURS IN MULTIPLE CHAMBERS
- PRIMARY CHAMBER IS ROTATING CYLINDER
  --PRODUCES TURBULENCE IN WASTE BED

SLIDE 3-11


To Atmosphere
Stack
BagHouse
Rotating Kiln
Secondary Chamber
Waste Heat Boiler
Waste Hopper
Bypass Stack
Exhaust Fan
Scrubber
Auger-Feeder
Ash

ROTARY KILN WITH AUGER FEED[4]

SLIDE 3-12

OPERATING MODE

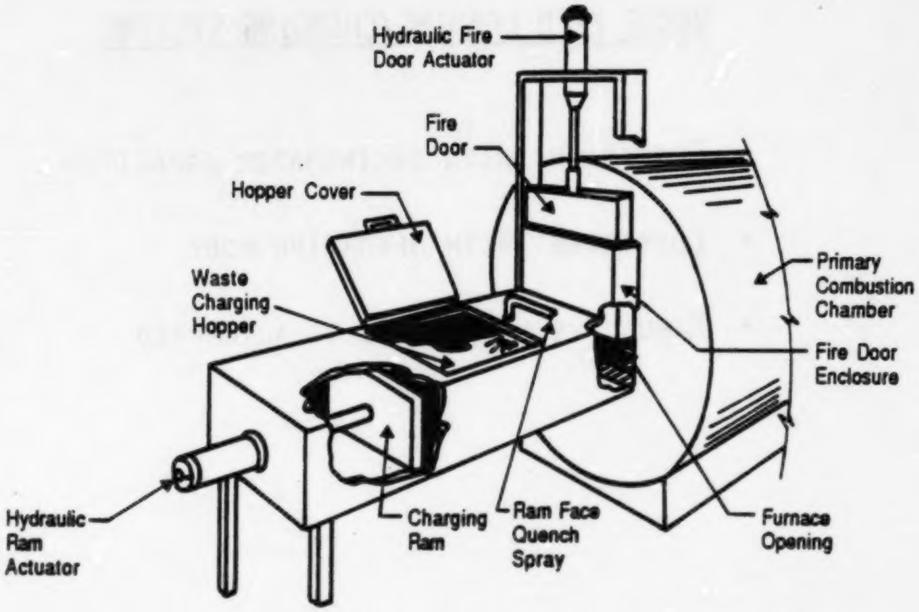
- SINGLE BATCH
- INTERMITTENT DUTY
- CONTINUOUS DUTY

Slide 3-13

WASTE FEED LOADING/CHARGING SYSTEMS

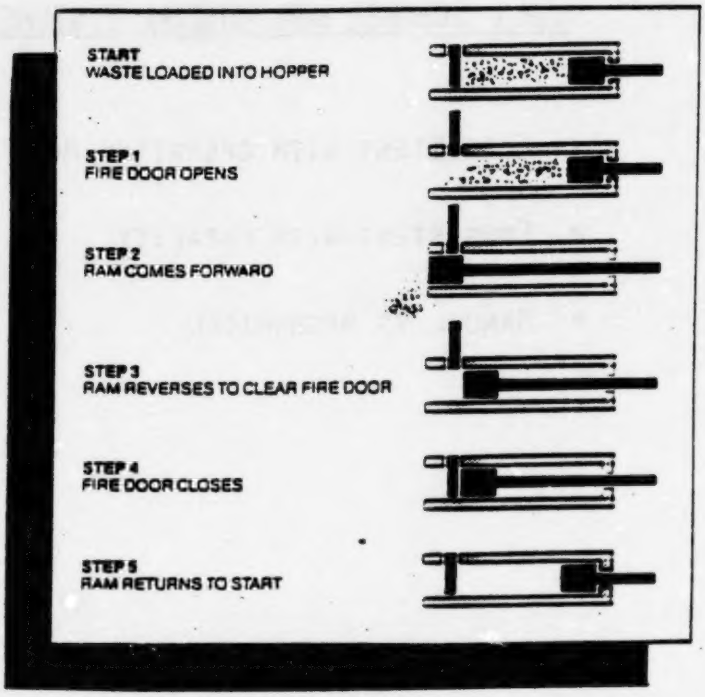
- Consistent with incinerator capacity
- Consistent with operating mode
- Manual vs mechanical vs automated

SLIDE 3-14


Hydraulic Fire Door Actuator
Fire Door
Hopper Cover
Waste Charging Hopper
Primary Combustion Chamber
Fire Door Enclosure
Hydraulic Ram Actuator
Charging Ram
Ram Face Quench Spray
Furnace Opening

HOPPER RAM ASSEMBLY[5]

SLIDE 3-15



START
WASTE LOADED INTO HOPPER

STEP 1
FIRE DOOR OPENS

STEP 2
RAM COMES FORWARD

STEP 3
RAM REVERSES TO CLEAR FIRE DOOR

STEP 4
FIRE DOOR CLOSES

STEP 5
RAM RETURNS TO START

HOPPER RAM CHARGING SEQUENCE [6]

SLIDE 3-16

ASH DISCHARGE AND REMOVAL SYSTEMS

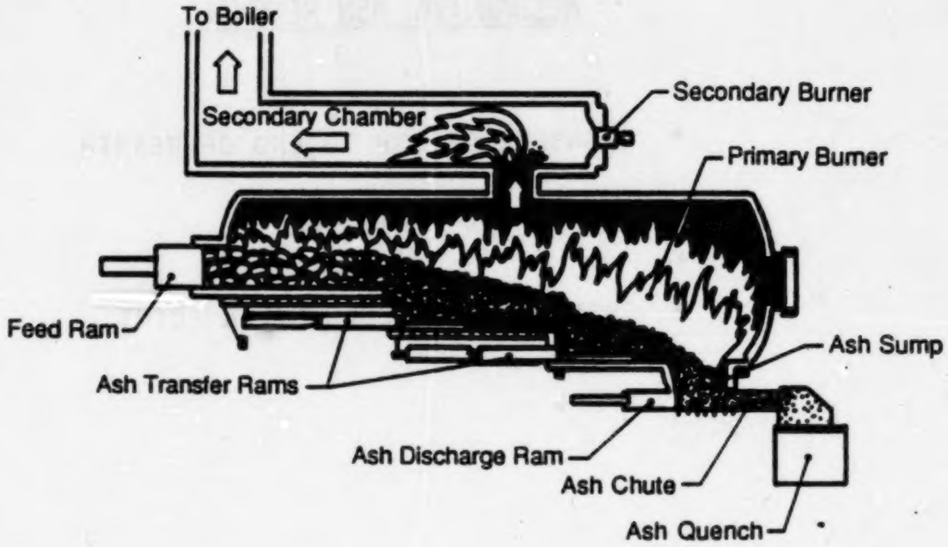
- CONSISTENT WITH OPERATING MODE
- CONSISTENT WITH CAPACITY
- MANUAL VS MECHANICAL

SLIDE 3-17

MECHANICAL ASH REMOVAL

- TRANSFER OF ASH TO END OF HEARTH
- COLLECTION CONTAINER
- TRANSFER FROM COLLECTION POINT

SLIDE 3-18


To Boiler
Secondary Burner
Secondary Chamber
Primary Burner
Feed Ram
Ash Sump
Ash Transfer Rams
Ash Discharge Ram
Ash Chute
Ash Quench

INCINERATOR WITH STAGED HEARTH AND AUTOMATIC ASH REMOVAL[7]

Slide 3-19

COMBUSTION GAS HANDLING SYSTEMS

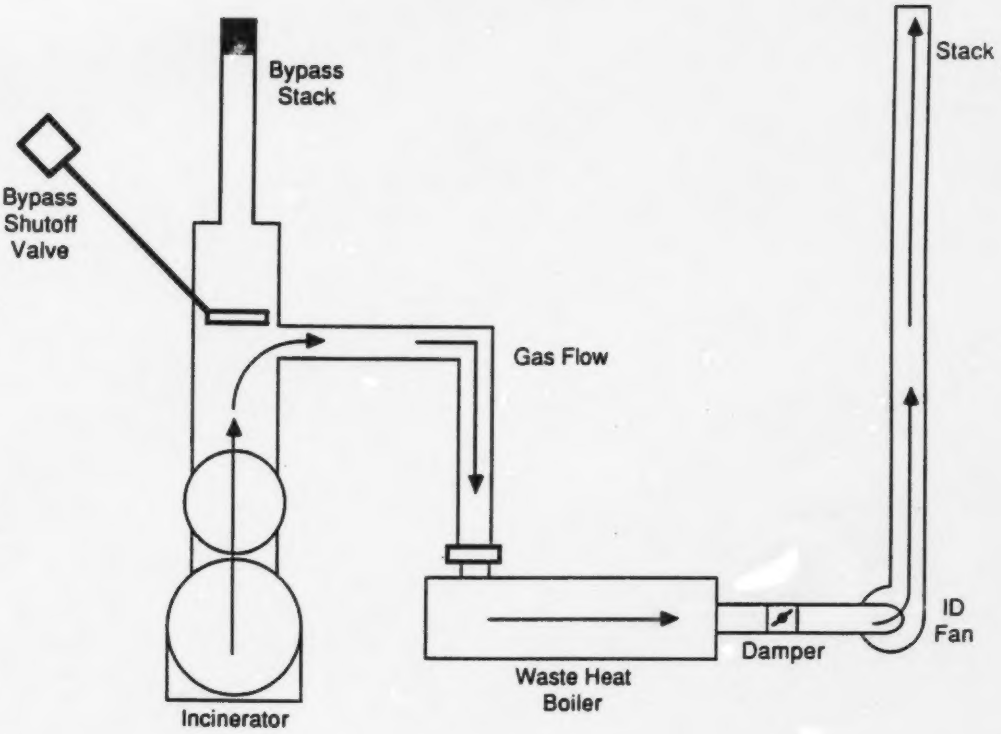
- Natural draft
- Induced draft
- Balanced draft

Slide 3-20

MAJOR COMPONENTS OF BURNER SYSTEM

- Forced air blower(s)
- Fuel train
- Pilot and main burner
- Flame safe guard system

SLIDE 3-21


Bypass Stack
Bypass Shutoff Valve
Stack
Gas Flow
ID Fan
Damper
Waste Heat Boiler
Incinerator

INCINERATOR WITH WASTE HEAT BOILER AND BYPASS STACK[2]

SESSION 4.

AIR POLLUTION CONTROL EQUIPMENT

DESIGN AND FUNCTIONS

Slide 4-1

CONTROL STRATEGIES FOR AIR POLLUTANTS

CONTROL strategy	POLLUTANT Particulate matter	Hydrochloric acid	Toxic organics	Toxic metals	Carbon monoxide
Controlling feed material	X	X		X	
Combustion control	X		X		X
Add-on pollution control equipment:					
Spray tower	a	X	a	a	
Venturi	X	a	a	X	
Packed-bed	a	X	a	a	
Fabric filter	X			X	
Dry injection[b]	X	X	a	X	
Dry scrubber[b]	X	X	a	X	
ESP	X				

[a] Achieves limited control; not designed for high efficiency.
[b] Followed by high-efficiency particulate control.

SLIDE 4-2

AIR POLLUTION CONTROL SYSTEMS FOR HOSPITAL WASTE INCINERATORS

- WET SCRUBBERS
  - -- SPRAY TOWERS
  - -- VENTURI SCRUBBERS
  - -- PACKED-BED SCRUBBERS

- FABRIC FILTERS

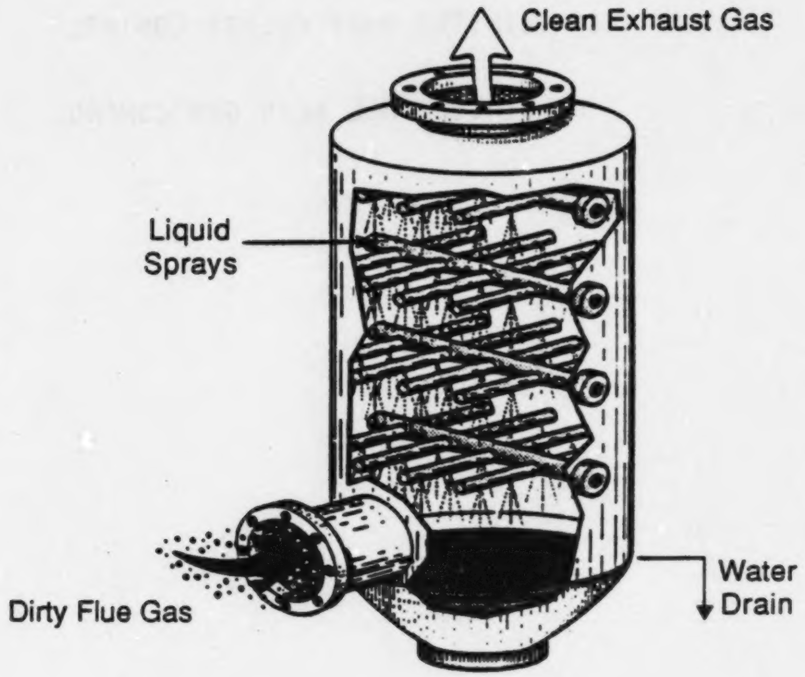
- DRY SCRUBBERS
  - -- DRY INJECTION
  - -- SPRAY DRYERS

- ELECTROSTATIC PRECIPITATORS

SPRAY TOWER

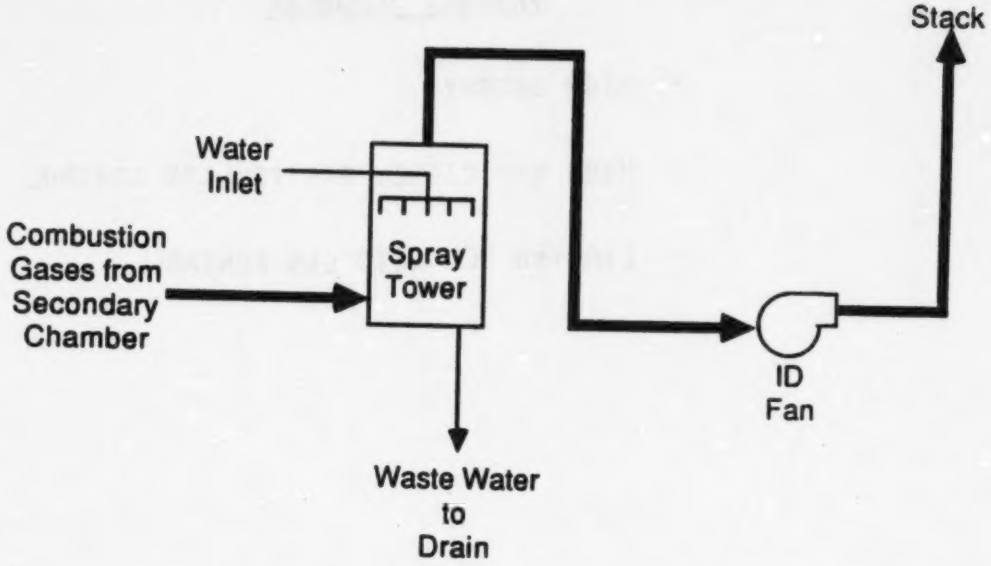
- LOW ENERGY
- LIMITED PARTICULATE CONTROL
- LIMITED HCL ACID GAS CONTROL

SLIDE 4-4


Clean Exhaust Gas
Liquid Sprays
Water Drain
Dirty Flue Gas

COUNTERCURRENT-FLOW SPRAY TOWER[1]

SLIDE 4-5


Water Inlet

Combustion Gases from Secondary Chamber

Spray Tower

Waste Water to Drain

ID Fan

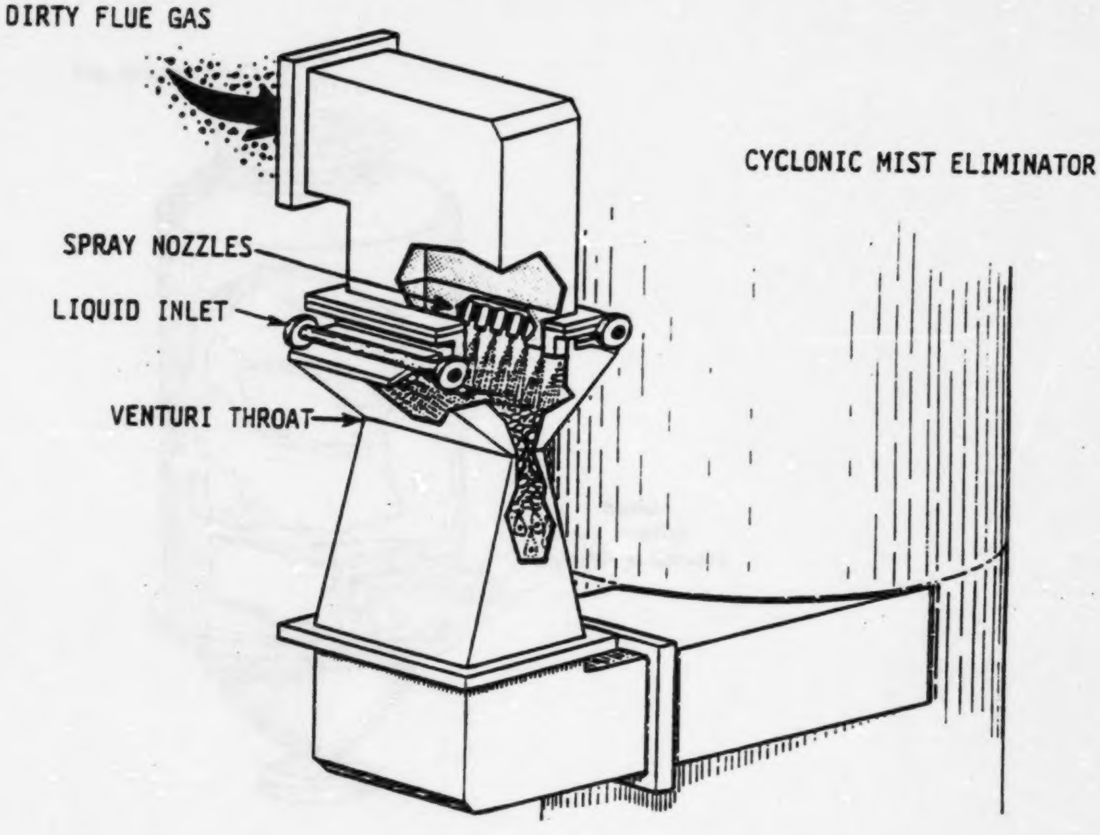
Stack

Spray Tower System

VENTURI SCRUBBER

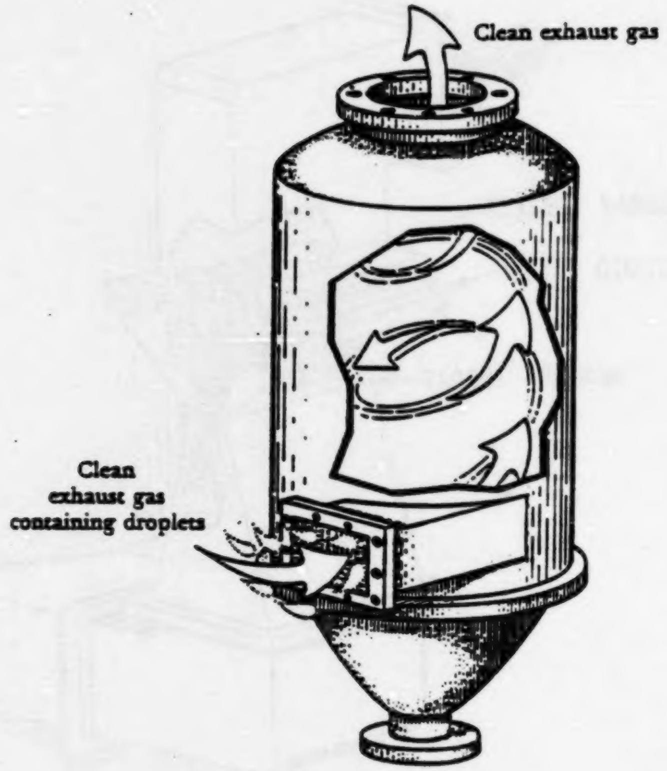
- HIGH ENERGY
- HIGH EFFICIENCY PARTICULATE CONTROL
- LIMITED HCL ACID GAS CONTROL

Slide 4-7


DIRTY FLUE GAS
CYCLONIC MIST ELIMINATOR
SPRAY NOZZLES
LIQUID INLET
VENTURI THROAT

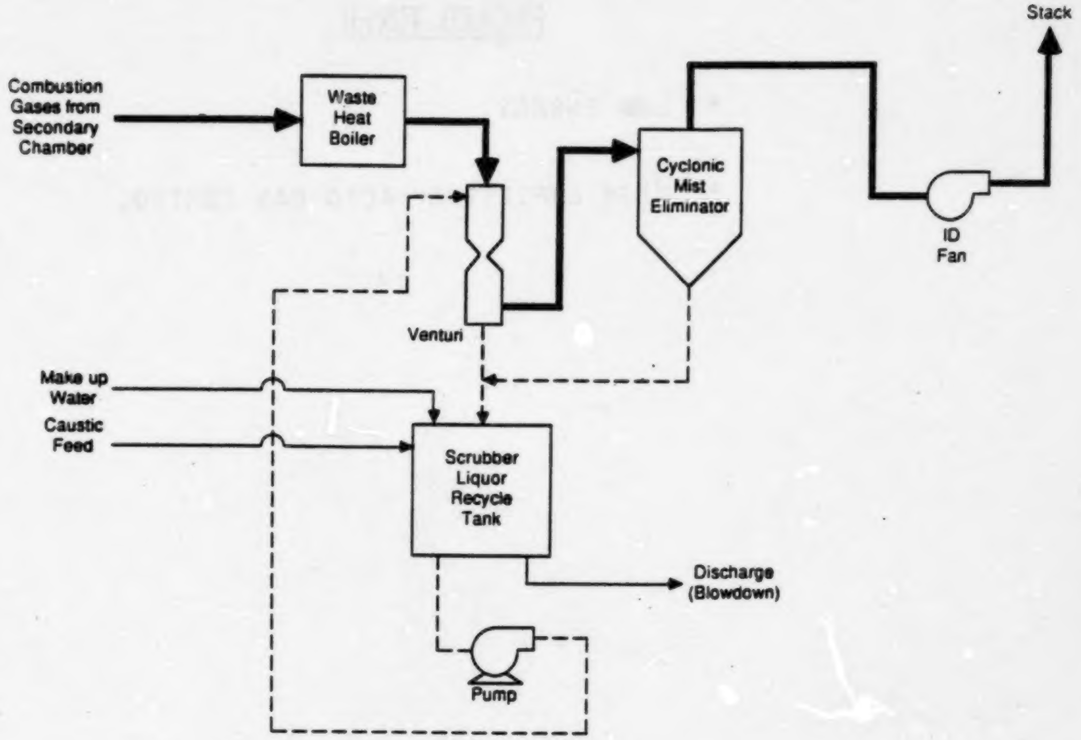
Spray venturi with rectangular throat[1]

SLIDE 4-8


Clean exhaust gas
Clean exhaust gas containing droplets

CYCLONIC MIST ELIMINATOR[1]

SLIDE 4-9



Combustion Gases from Secondary Chamber
Waste Heat Boiler
Venturi
Cyclonic Mist Eliminator
Stack
ID Fan
Make up Water
Caustic Feed
Scrubber Liquor Recycle Tank
Discharge (Blowdown)
Pump

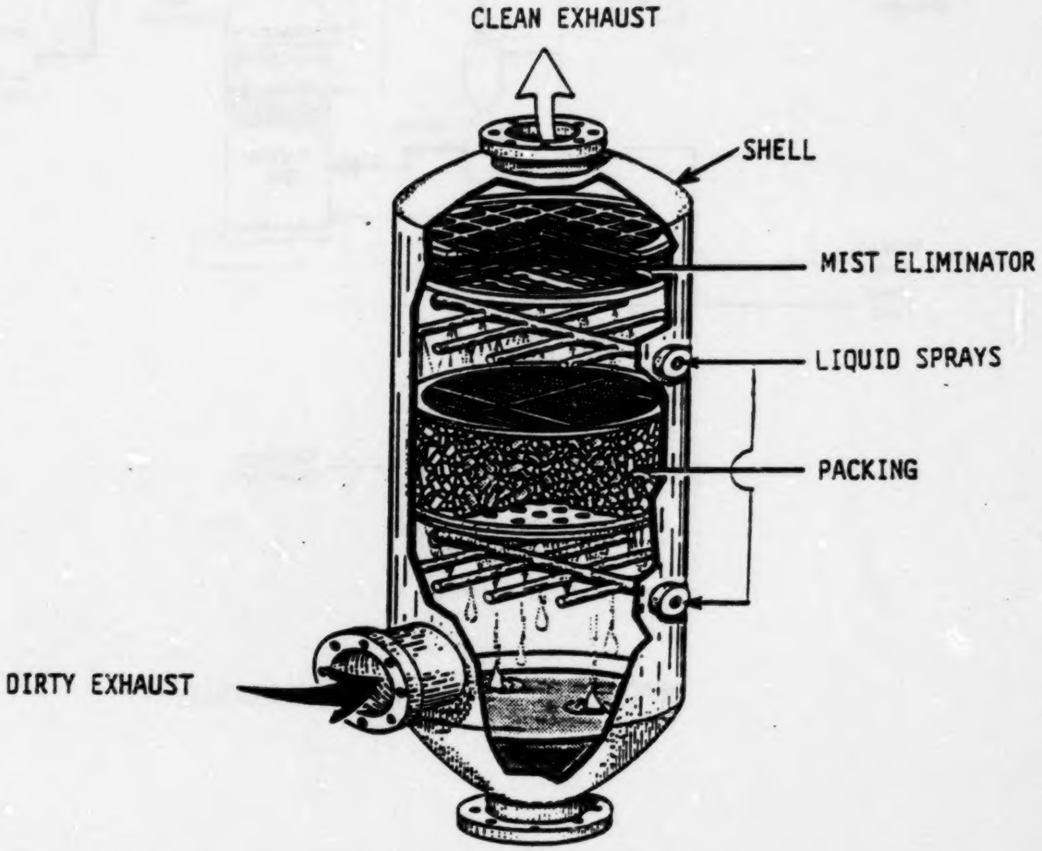
VENTURI SCRUBBER SYSTEM WITH
RECIRCULATED SCRUBBER LIQUOR

SLIDE 4-10

PACKED TOWER

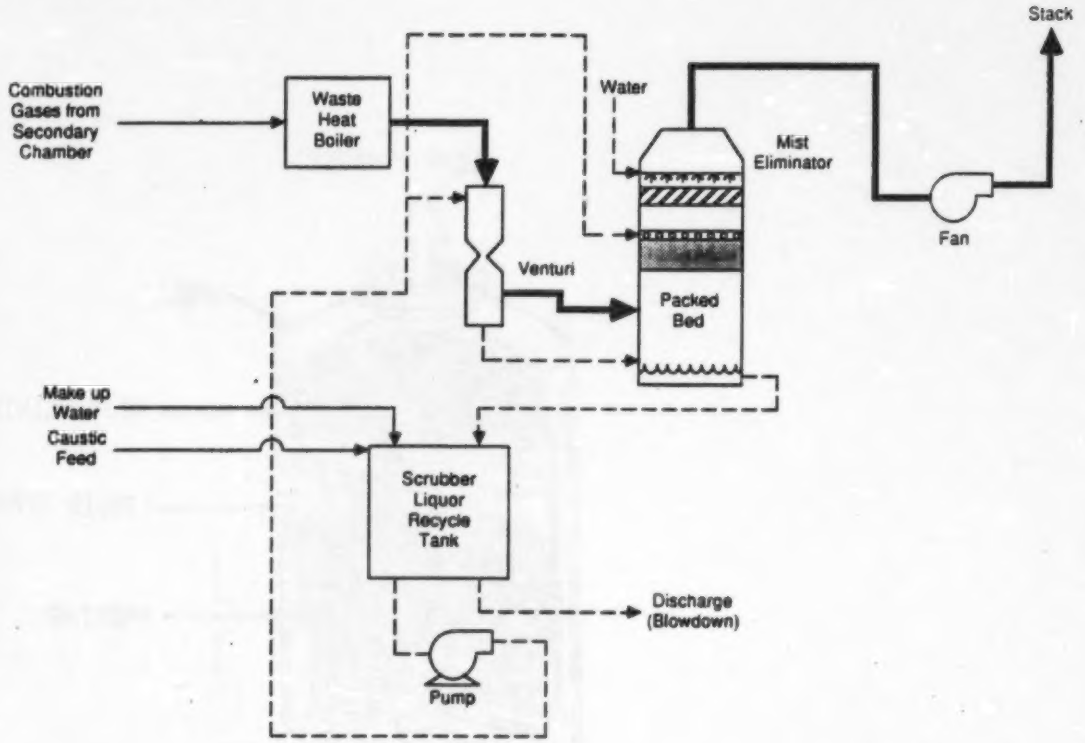
- LOW ENERGY
- HIGH EFFICIENCY ACID GAS CONTROL

SLIDE 4-11


CLEAN EXHAUST
SHELL
MIST ELIMINATOR
LIQUID SPRAYS
PACKING
DIRTY EXHAUST

COUNTERCURRENT-FLOW
PACKED-BED SCRUBBER[1]

SLIDE 4-12


Combustion Gases from Secondary Chamber
Waste Heat Boiler
Water
Stack
Mist Eliminator
Fan
Venturi
Packed Bed
Make up Water
Caustic Feed
Scrubber Liquor Recycle Tank
Discharge (Blowdown)
Pump

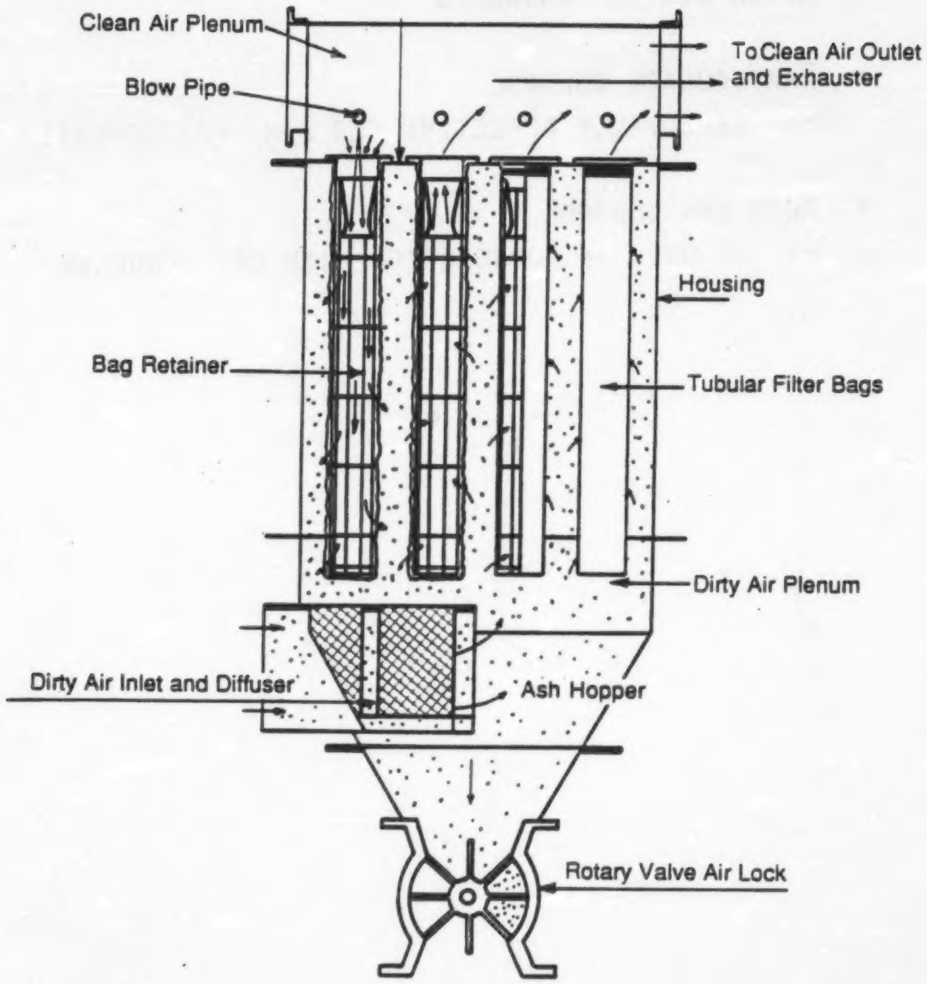
VENTURI SCRUBBER WITH PACKED BED

Slide 4-13

FABRIC FILTER

- Often called "baghouse"
- Particulate control
  -- especially effective for fine particulate
- Acid gas control
  -- if used in conjunction with dry scrubber

SLIDE 4-14


Clean Air Plenum
Blow Pipe
To Clean Air Outlet and Exhauster
Housing
Bag Retainer
Tubular Filter Bags
Dirty Air Plenum
Dirty Air Inlet and Diffuser
Ash Hopper
Rotary Valve Air Lock

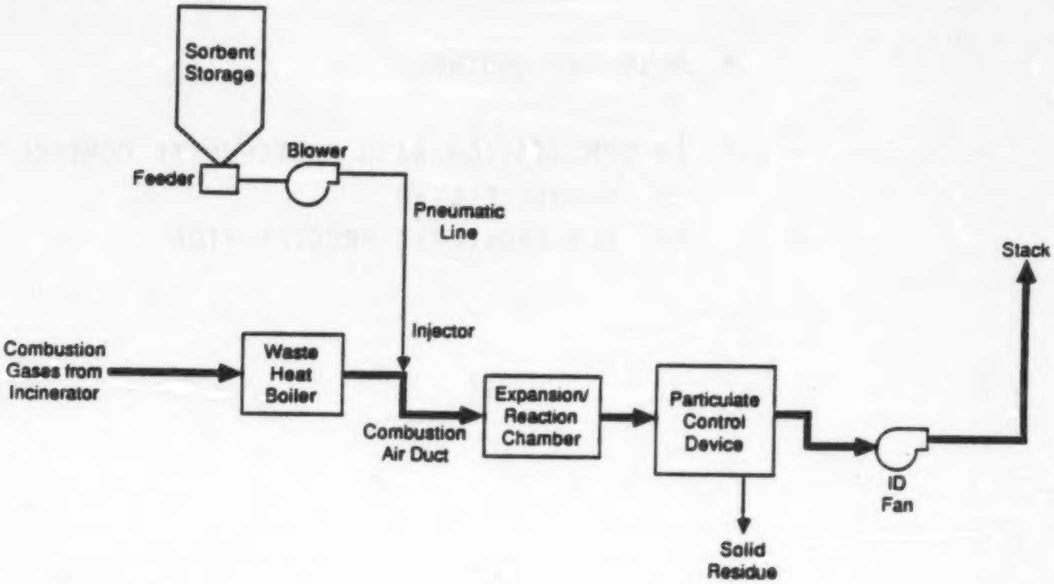
PULSE JET BAGHOUSE[2]

Slide 4-15

DRY SCRUBBERS

- Acid gas control
- In conjunction with particulate control
  - -- fabric filter
  - -- electrostatic precipitator

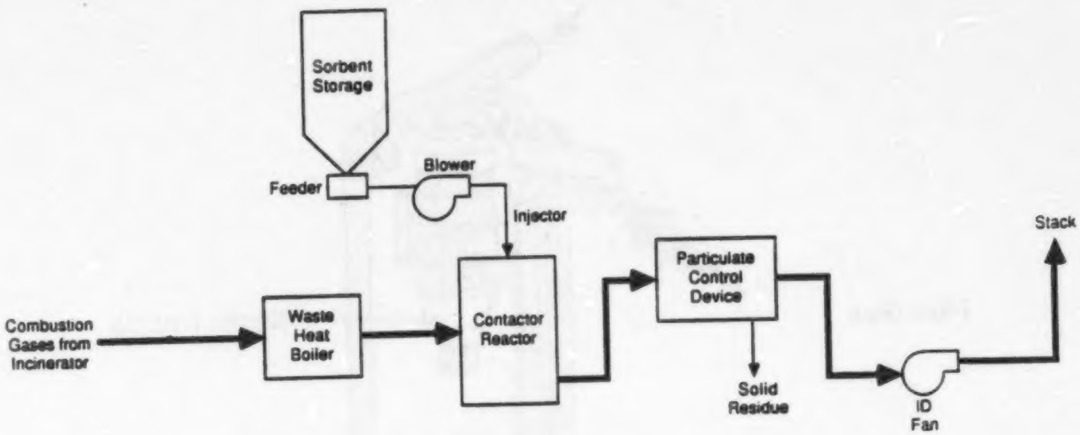
SLIDE 4-16A



Sorbent Storage
Blower
Feeder
Pneumatic Line
Stack
Injector
Combustion Gases from Incinerator
Waste Heat Boiler
Expansion/ Reaction Chamber
Particulate Control Device
Combustion Air Duct
ID Fan
Solid Residue

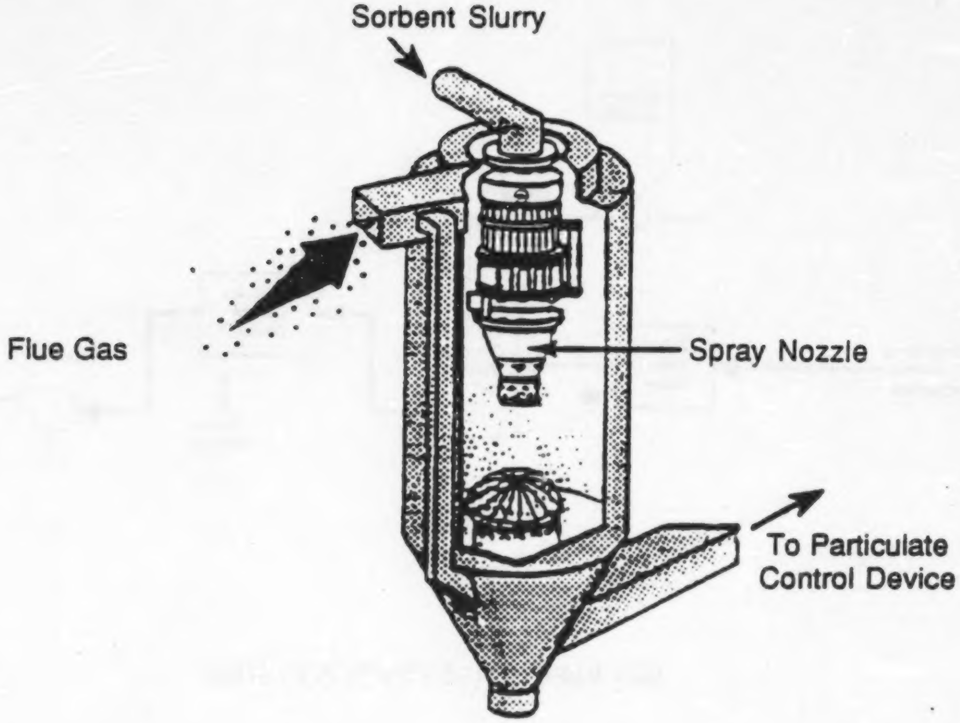
DRY INJECTION ABSORPTION SYSTEM

SLIDE 4-16B


Sorbent Storage
Feeder
Blower
Injector
Stack
Particulate Control Device
Combustion Gases from Incinerator
Waste Heat Boiler
Contactor Reactor
Solid Residue
ID Fan

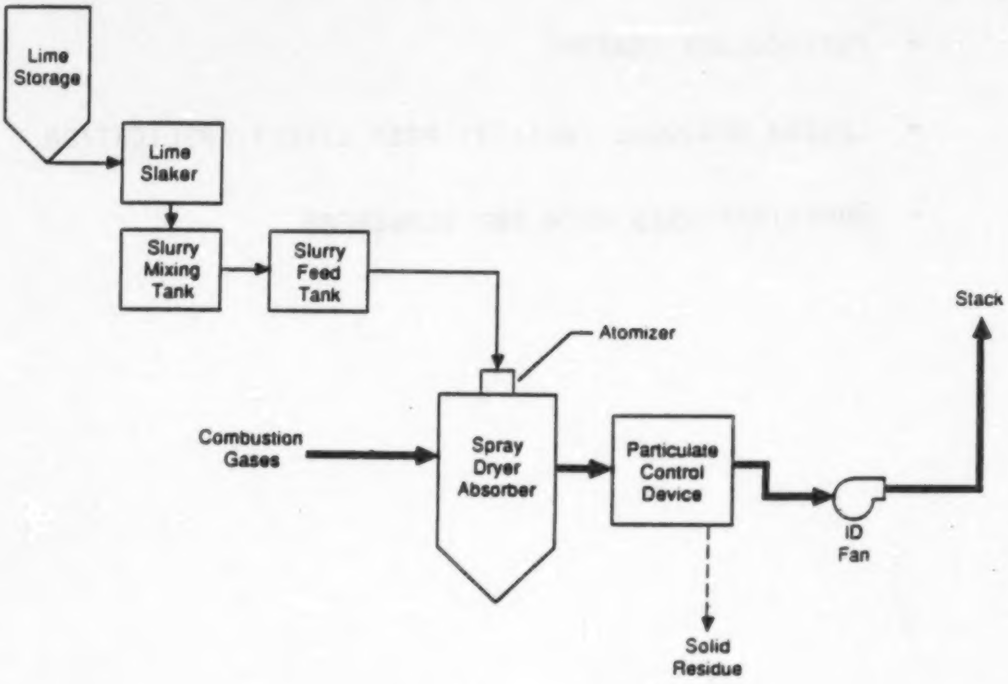
DRY INJECTION ABSORPTION SYSTEM

SLIDE 4-17


Sorbent Slurry
Flue Gas
Spray Nozzle
To Particulate
Control Device

SPRAY DRYER ABSORBER VESSEL

SLIDE 4-18


Lime Storage
Lime Slaker
Slurry Mixing Tank
Slurry Feed Tank
Atomizer
Stack
Combustion Gases
Spray Dryer Absorber
Particulate Control Device
ID Fan
Solid Residue

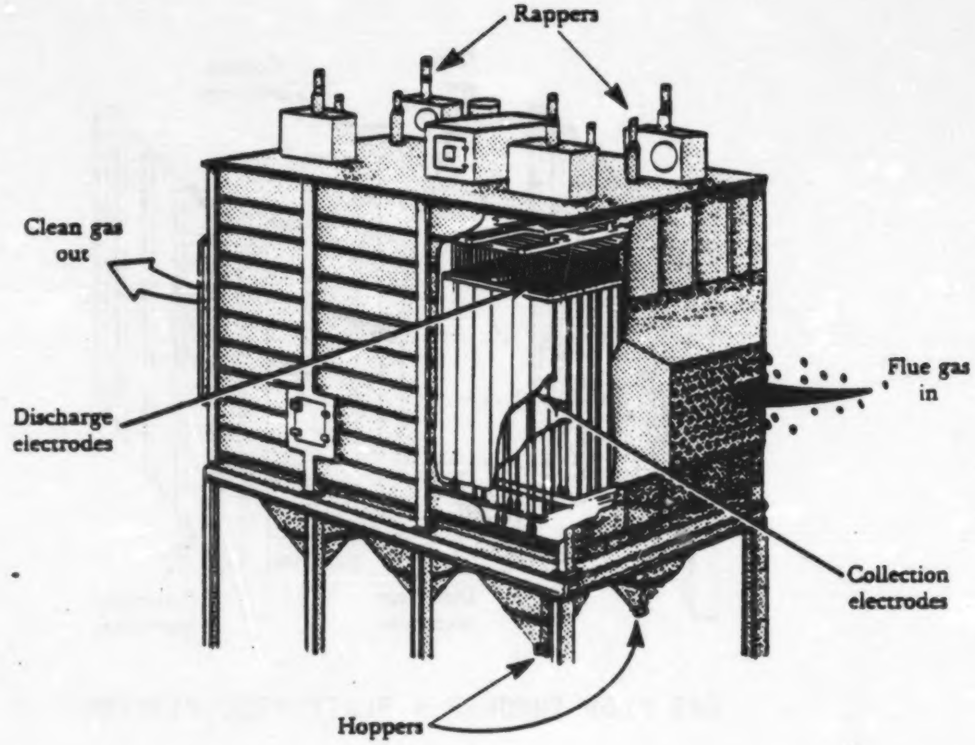
COMPONENTS OF A SPRAY DRYER ABSORBER SYSTEM

SLIDE 4-19

ELECTROSTATIC PRECIPITATORS

- PARTICULATE CONTROL
- LARGER REGIONAL FACILITY MOST LIKELY APPLICATION
- SOMETIMES USED WITH DRY SCRUBBERS

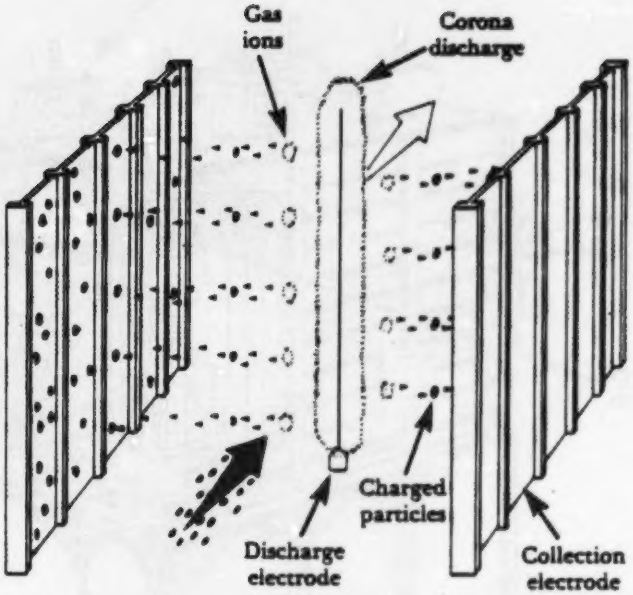
SLIDE 4-20



Rappers
Clean gas out
Flue gas in
Discharge electrodes
Collection electrodes
Hoppers

COMPONENTS OF AN ESP

SLIDE 4-21


Gas ions
Corona discharge
Charged particles
Discharge electrode
Collection electrode

GAS FLOW THROUGH A PLATE PRECIPITATOR[3]

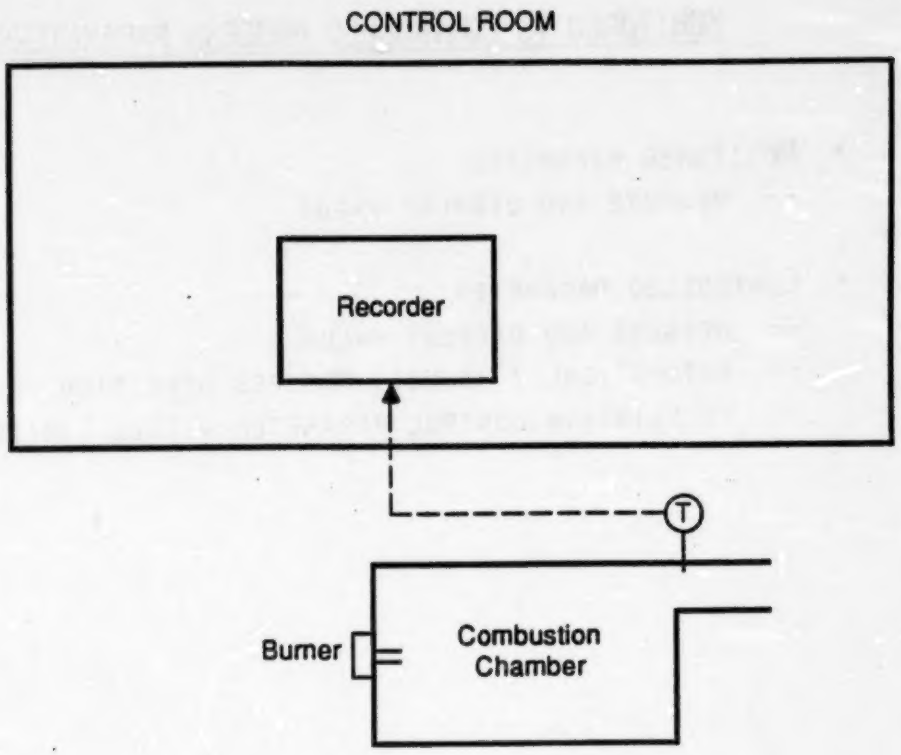
SESSION 5.
MONITORING AND AUTOMATIC CONTROL SYSTEMS

Slide 5-1

MONITORED VS CONTROLLED PROCESS PARAMETERS

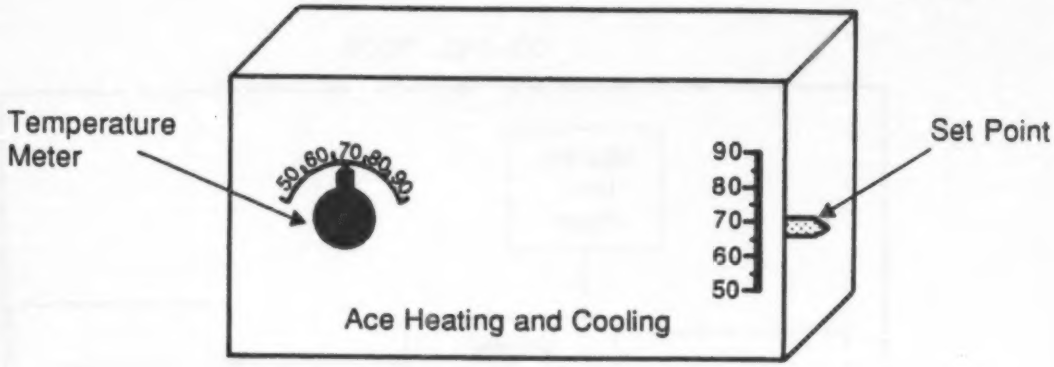
- Monitored parameter
  - -- MEASURE AND DISPLAY VALUE
- Controlled parameter
  - -- MEASURE AND DISPLAY VALUE
  - -- AUTOMATICALLY ADJUSTS PROCESS OPERATION TO MAINTAIN CONTROL PARAMETER WITHIN LIMITS

SLIDE 5-2


CONTROL ROOM
Recorder
T
Burner
Combustion Chamber

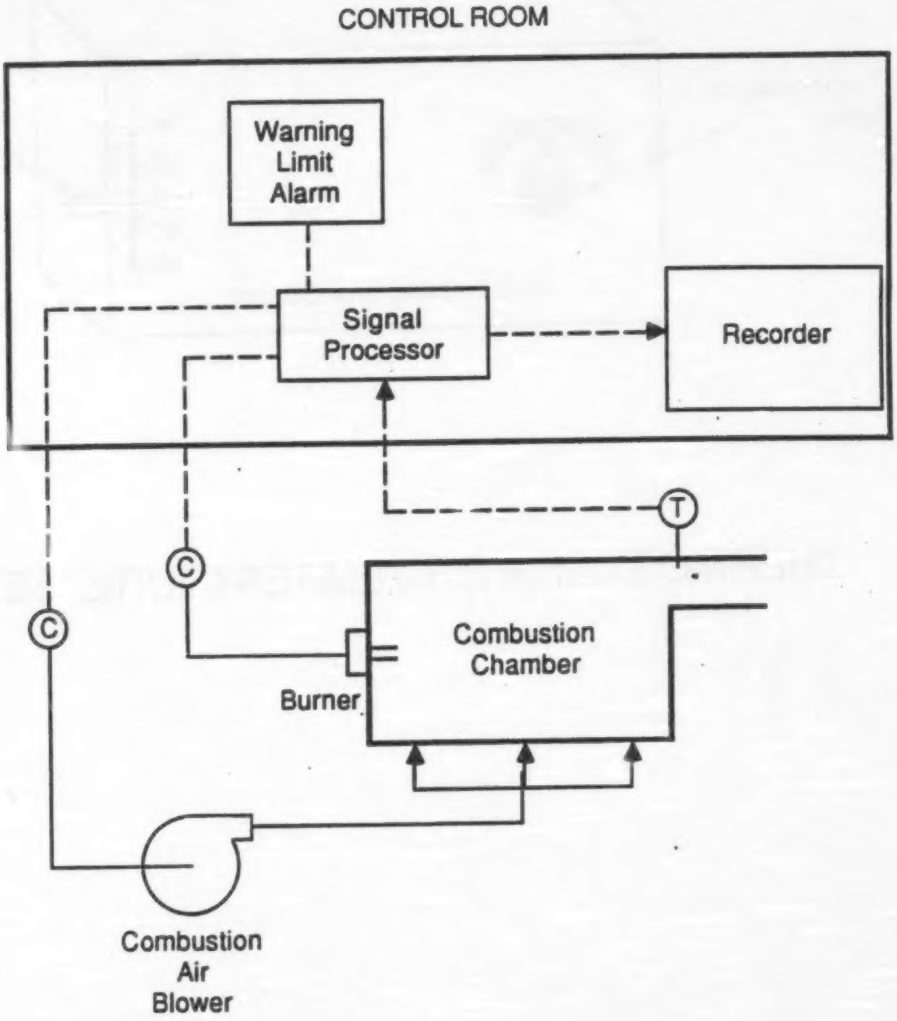
TEMPERATURE MONITORING SYSTEM

SLIDE 5-3


Temperature Meter
50
60
70
80
90
Set Point
90
80
70
60
50
Ace Heating and Cooling

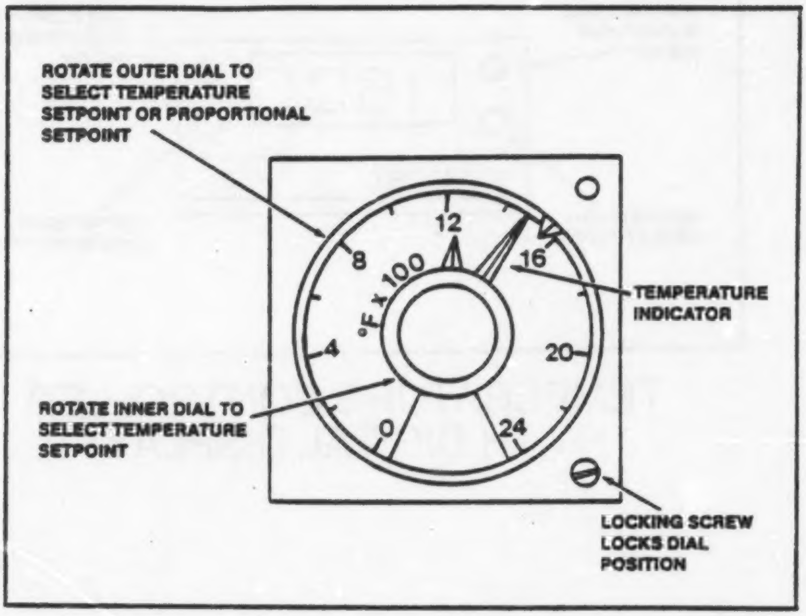
THERMOSTAT WITH TEMPERATURE "SET POINT"

SLIDE 5-4


CONTROL ROOM
Warning Limit Alarm
Signal Processor
Recorder
T
C
C
Combustion Chamber
Burner
Combustion Air Blower

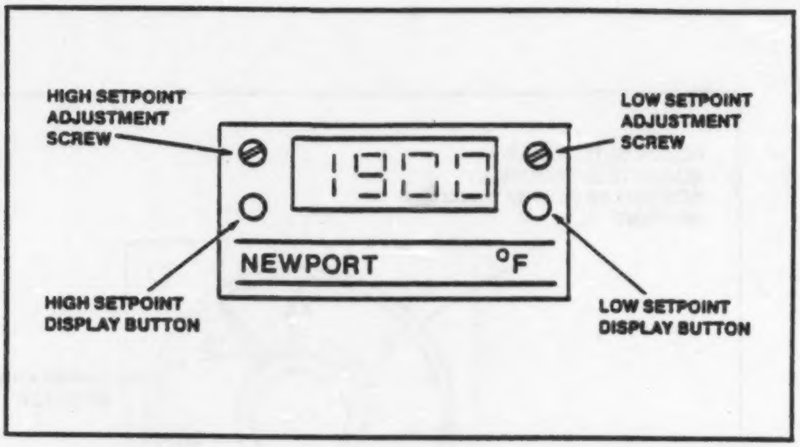
SCHEMATIC OF TEMPERATURE CONTROL LOOP

SLIDE 5-5


ROTATE OUTER DIAL TO SELECT TEMPERATURE SETPOINT OR PROPORTIONAL SETPOINT
12
8
16
°F x 100
TEMPERATURE INDICATOR
4
20
ROTATE INNER DIAL TO SELECT TEMPERATURE SETPOINT
0
24
LOCKING SCREW LOCKS DIAL POSITION

TEMPERATURE CONTROLLER/METER WITH LOW/HIGH SETPOINTS[1]

Slide 5-6


HIGH SETPOINT
ADJUSTMENT
SCREW
LOW SETPOINT
ADJUSTMENT
SCREW
1900
NEWPORT
°F
HIGH SETPOINT
DISPLAY BUTTON
LOW SETPOINT
DISPLAY BUTTON

TEMPERATURE CONTROLLER
WITH DIGITAL DISPLAY[1]

SLIDE 5-7

BASIC TYPES OF INCINERATOR PROCESS CONTROL SYSTEMS

- MANUAL
- AUTOMATIC TIMER SEQUENCE
- AUTOMATIC MODULATED CONTROL

Slide 5-8

AUTOMATIC TIMER SEQUENCE

- Preset timer sequence
  - -- ACTIVATES ON/OFF OR HIGH/LOW SETTINGS
    - BURNERS
    - COMBUSTION AIR
    - CHARGE FEEDER
- Setpoint limits override timer sequence

SLIDE 5-9

AUTOMATIC MODULATED CONTROL

- SETPOINT FOR CONTROLLED PARAMETER IS CHOSEN
- OPERATING PARAMETERS ARE CONTINUOUSLY ADJUSTED TO MAINTAIN SETPOINT
  -- COMBUSTION AIR

SLIDE 5-10

MONITORED AND CONTROLLED PROCESS PARAMETERS FOR INCINERATORS

MONITORED/CONTROLLED PARAMETER	INCINERATOR FUNCTIONS CONTROLLED
TEMPERATURE (PRIMARY AND SECONDARY CHAMBERS)	COMBUSTION AIR AUXILIARY BURNERS
DRAFT	BAROMETRIC DAMPER ID FAN DAMPER
OXYGEN	COMBUSTION AIR
CARBON MONOXIDE	--
OPACITY	--
CHARGE RATE	AUTOMATIC FEED INTERLOCK

SLIDE 5-11

MONITORED AND CONTROLLED PROCESS PARAMETERS FOR SCRUBBERS

MONITORED PARAMETER	SCRUBBER FUNCTIONS CONTROLLED
PRESSURE AND PRESSURE DROP	VENTURI THROAT ID FAN
SCRUBBER LIQUID FLOW RATE OR PRESSURE	LIQUID FLOW CONTROL VALVE
SCRUBBER LIQUID pH	CAUSTIC FLOW CONTROL VALVE
INLET TEMPERATURE	PREQUENCH EMERGENCY QUENCH BYPASS STACK DILUTION AIR

SLIDE 5-12

MONITORED AND CONTROLLED PROCESS PARAMETERS FOR FABRIC FILTERS

MONITORED PARAMETER	FABRIC FILTER OPERATING FUNCTIONS CONTROLLED
PRESSURE DROP	CLEANING CYCLE
INLET GAS TEMPERATURE	EMERGENCY BYPASS STACK EMERGENCY QUENCH DILUTION AIR

Slide 5-13

MONITORED AND CONTROLLED PROCESS PARAMETERS FOR ESP's

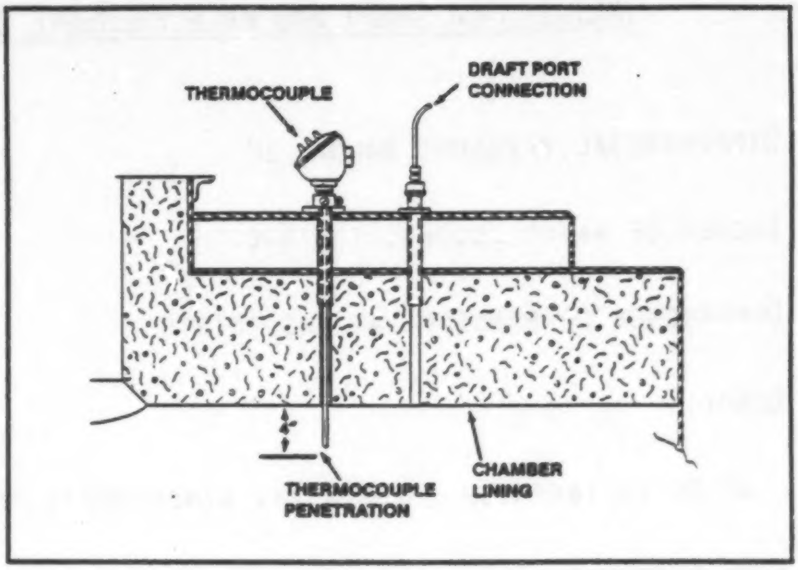
Monitored parameter	ESP operating functions controlled
• Power input -- primary voltage -- primary current -- secondary voltage -- secondary current	Power supply T/R settings
• Spark rate	Gas temperature Rapper operation Conditioning agents (resistivity)
• Inlet gas temperature	Increase/decrease incinerator or boiler outlet temperature Condition gas

SLIDE 5-14

TEMPERATURE

- THERMOCOUPLE(S)
- DEGREES FAHRENHEIT
- EXIT OF SECONDARY COMBUSTION CHAMBER
- MIDDLE OF PRIMARY CHAMBER
- BEFORE/AFTER APC

SLIDE 5-15


THERMOCOUPLE
DRAFT PORT CONNECTION
4"
THERMOCOUPLE PENETRATION
CHAMBER LINING

THERMOCOUPLE AND DRAFT GAUGE CONNECTIONS [1]

SLIDE 5-16

INCINERATOR DRAFT AND APCS PRESSURE DROP

- DIFFERENTIAL PRESSURE GAUGE, ΔP
- INCHES OF WATER COLUMN, IN. W.C.
- DIFFERENCE OF PRESSURE AT TWO POINTS

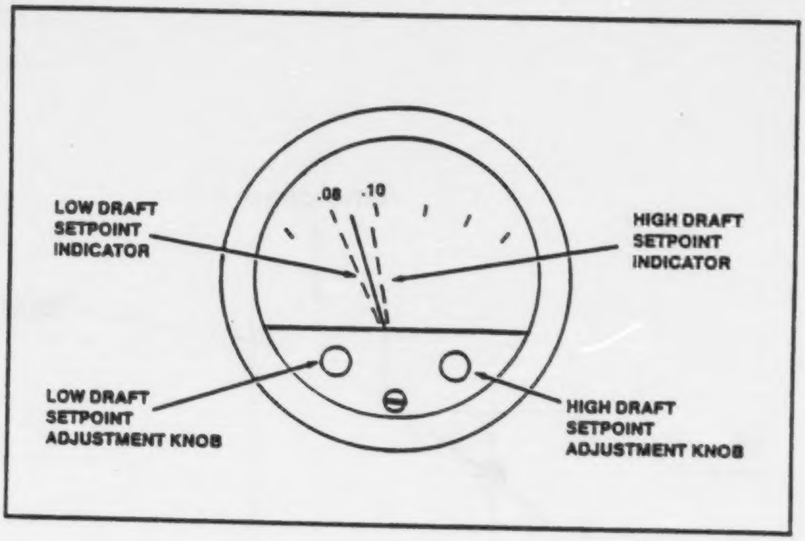
DRAFT:

ΔP OF INCINERATOR CHAMBER AND ATMOSPHERIC PRESSURE

APCS PRESSURE DROP:

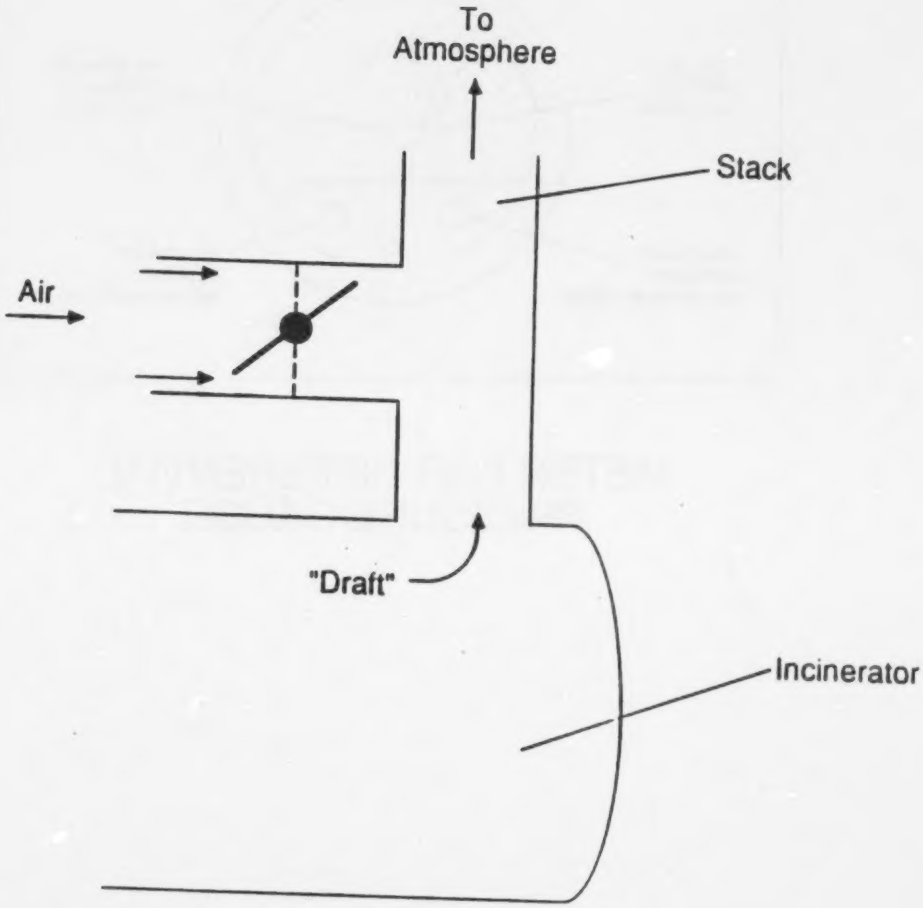
ΔP BEFORE AND AFTER APC

SLIDE 5-17


.08
.10
LOW DRAFT SETPOINT INDICATOR
HIGH DRAFT SETPOINT INDICATOR
LOW DRAFT SETPOINT ADJUSTMENT KNOB
HIGH DRAFT SETPOINT ADJUSTMENT KNOB

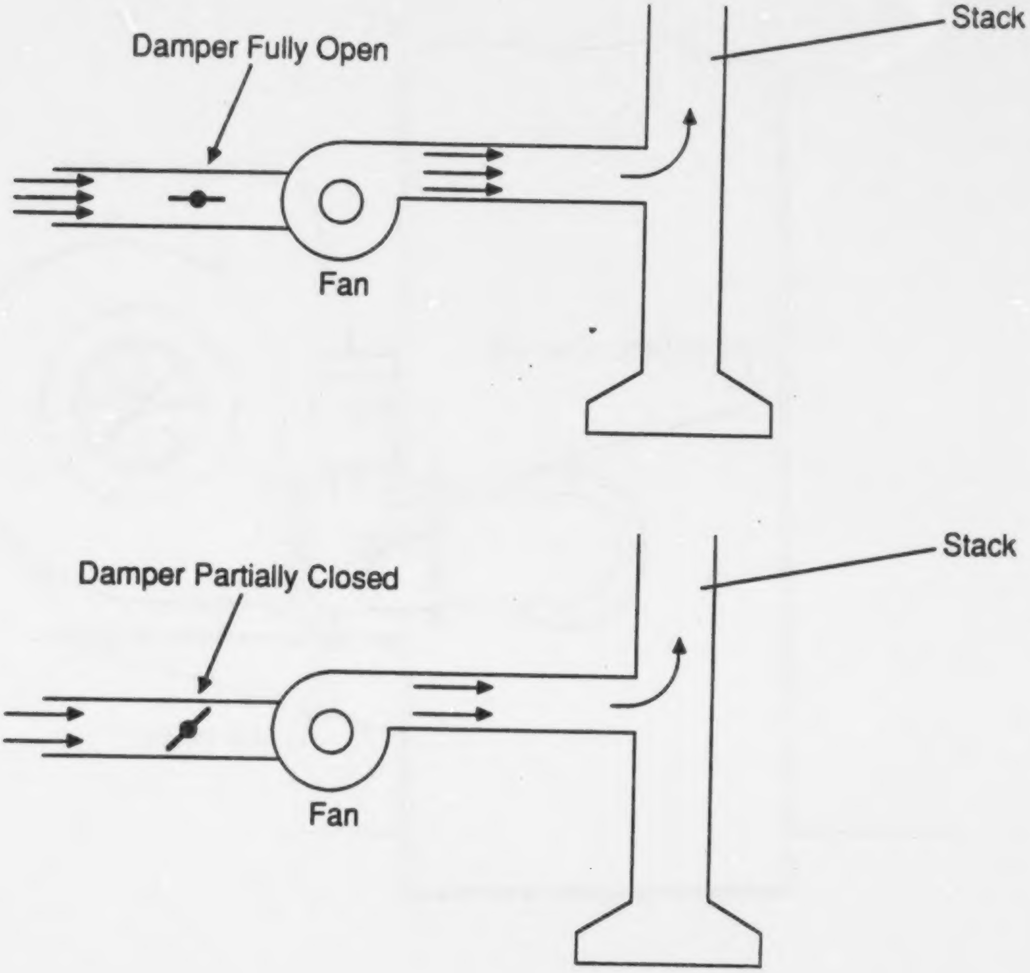
METER FOR DIFFERENTIAL PRESSURE GAUGE[1]

SLIDE 5-18


To
Atmosphere
Stack
Air
"Draft"
Incinerator

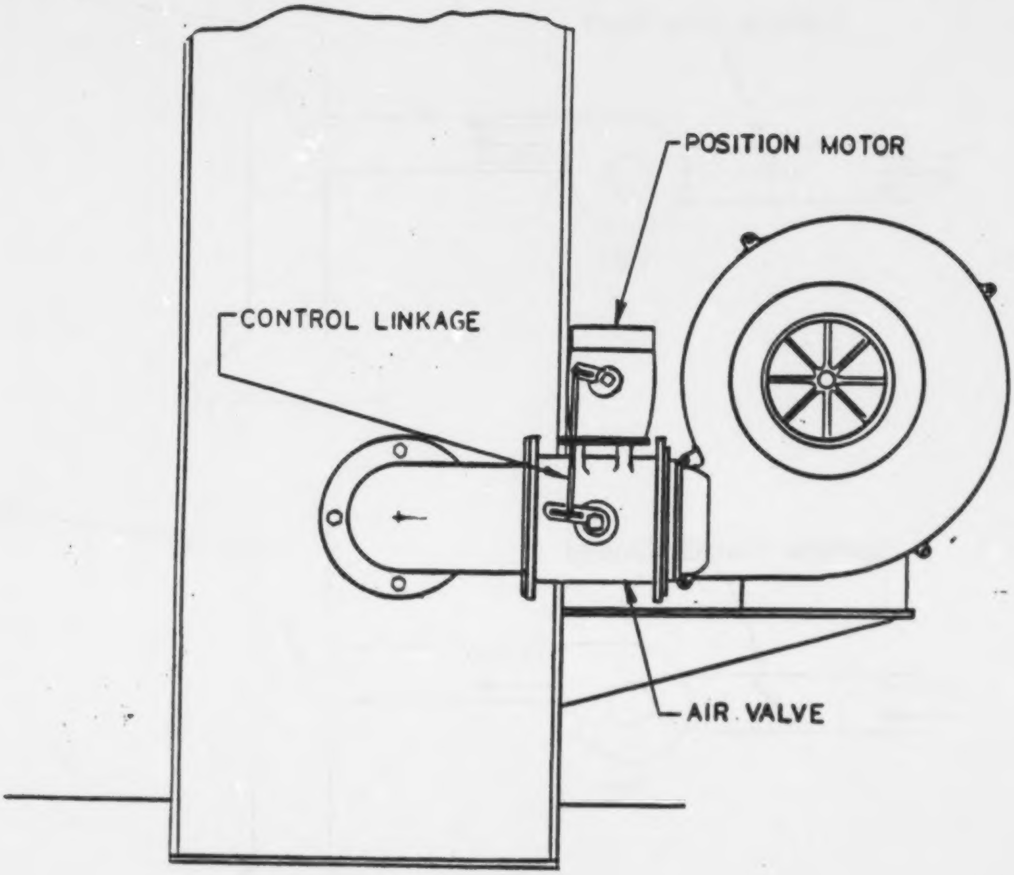
BAROMETRIC/AUTOMATIC DAMPER

SLIDE 5-19


Damper Fully Open
Stack
Fan
Damper Partially Closed
Stack
Fan

ID FAN DAMPER CONTROL

SLIDE 5-20


POSITION MOTOR
CONTROL LINKAGE
AIR VALVE

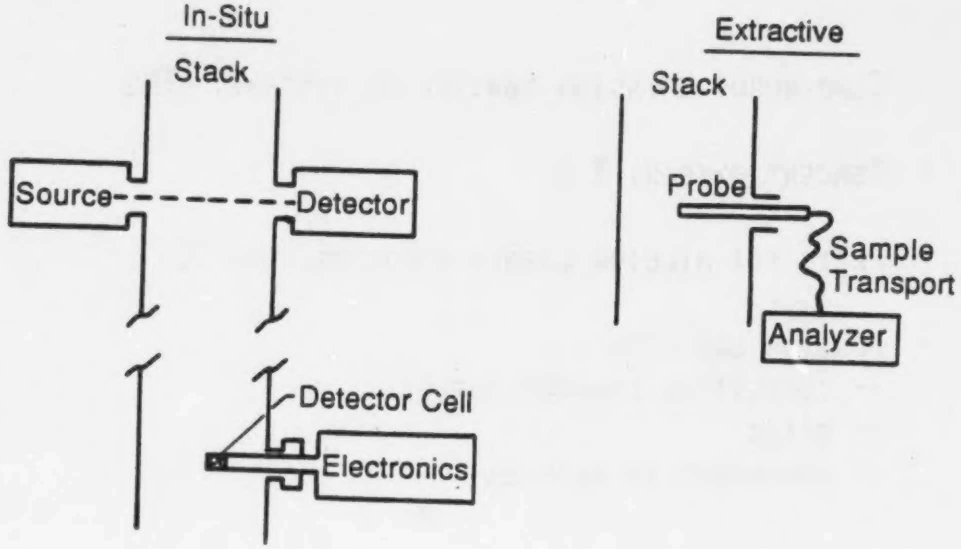
COMBUSTION BLOWER
WITH AUTOMATIC CONTROLLER[1]

SLIDE 5-21

OXYGEN AND CO MONITORS

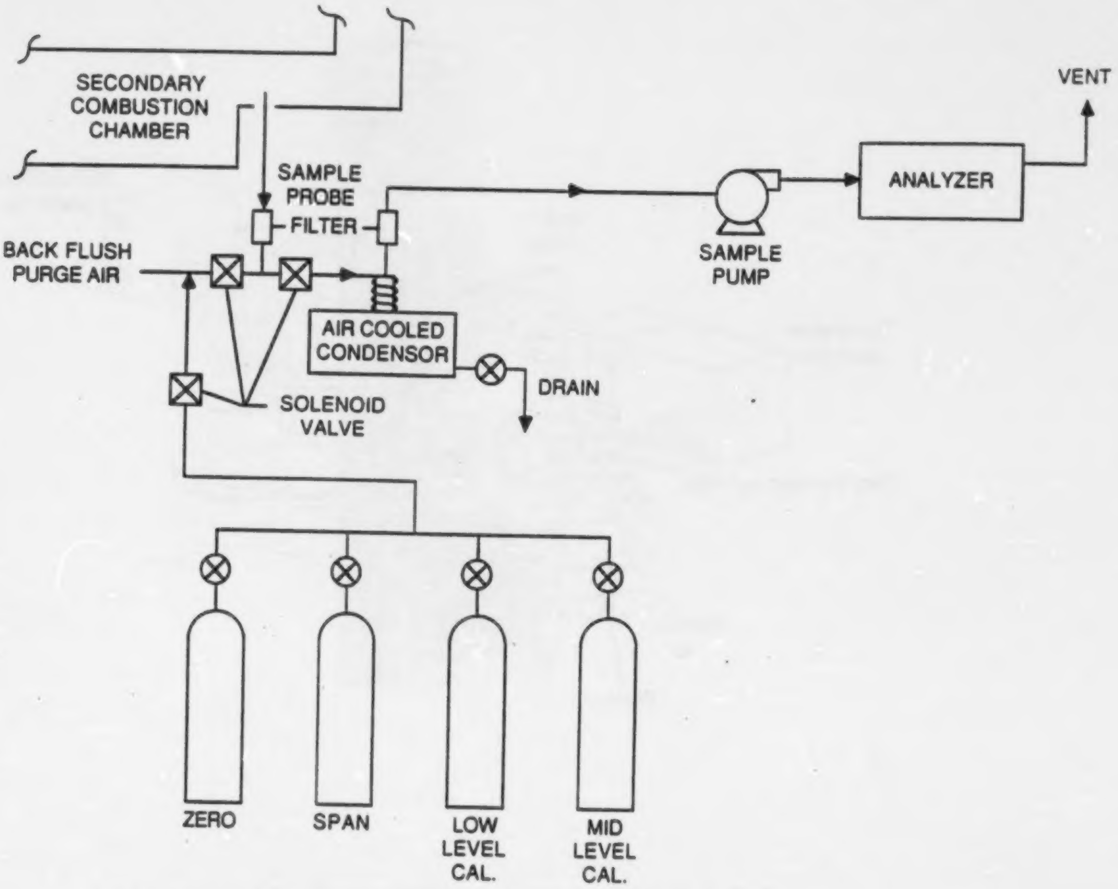
- CONTINUOUS EMISSION MONITORING SYSTEMS, CEMS
- PERCENT OXYGEN, % O_2
- PARTS PER MILLION CARBON MONOXIDE, PPM CO
- MONITOR LOCATION
  -- COMBUSTION CHAMBER OUTLET
  -- STACK
  -- SOMEWHERE IN BETWEEN

SLIDE 5-22


In-Situ
Stack
Source
Detector
Detector Cell
Electronics
Extractive
Stack
Probe
Sample Transport
Analyzer

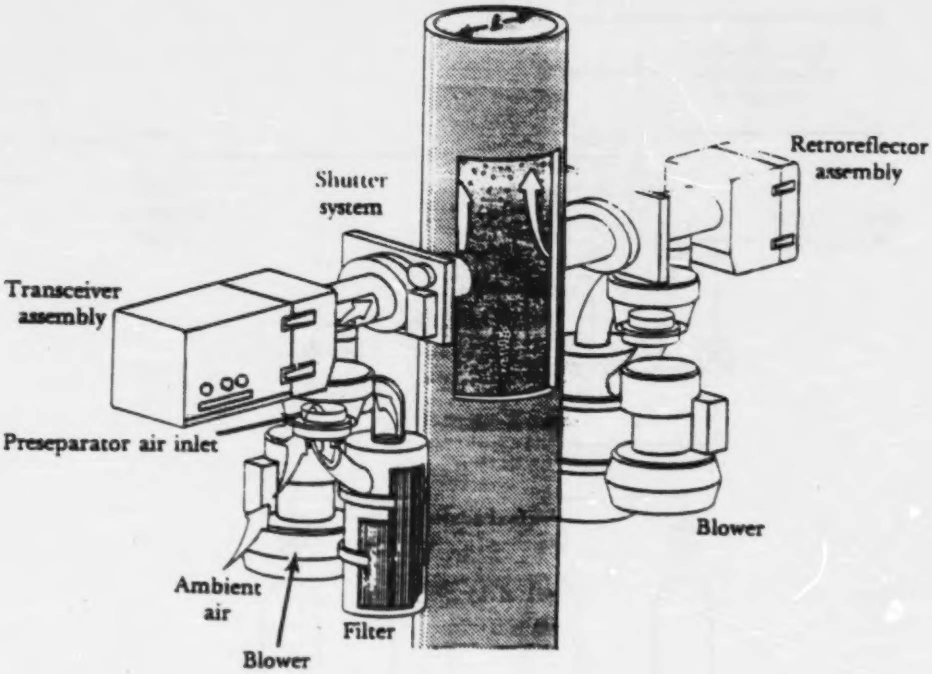
IN SITU VS EXTRACTIVE CEMS

SLIDE 5-23


SECONDARY
COMBUSTION
CHAMBER
SAMPLE
PROBE
FILTER
BACK FLUSH
PURGE AIR
AIR COOLED
CONDENSOR
DRAIN
SOLENOID
VALVE
SAMPLE
PUMP
ANALYZER
VENT
ZERO
SPAN
LOW
LEVEL
CAL.
MID
LEVEL
CAL.

EXTRACTIVE MONITORING SYSTEM

SLIDE 5-24


Retroreflector assembly
Shutter system
Transceiver assembly
Preseparator air inlet
Blower
Ambient air
Filter
Blower

OPACITY MONITORING SYSTEM [2]
(Transmissometer)

SLIDE 5-25

CHARGE RATE

- LB/LOAD
- LB/H
- WEIGH SCALE/LOG BOOK
- AUTOMATIC WEIGH SCALE OR WEIGH HOPPER

Slide 5-26

APC MONITORS

- Scrubber liquid flow
  - GALLONS PER MINUTE, GPM
  - FLOW METER
  - PUMP PRESSURE
- pH of scrubber liquid
  - pH METER
- Temperature
  - THERMOCOUPLE
- Pressure drop, ΔP
  - DIFFERENTIAL PRESSURE GAUGE

SESSION 6.

INCINERATOR OPERATION

Slide 6-1

TOPICS

- Waste Handling
- Operation of Controlled-Air Incinerators
- Operation of Excess-Air Incinerators

SLIDE 6-2

WASTE HANDLING

- STURDY CONTAINERS
- MINIMIZE HANDLING
- PROPERLY OPERATE/MAINTAIN WASTE CHARGING DEVICES
- SAFE STORAGE--EVEN FOR SHORT TIMES

SLIDE 6-3

INCINERATOR OPERATION

- KEY OPERATING PARAMETERS
- OPERATING RANGES
- MONITORING OPERATION
- CONTROLLING OPERATION
- WASTE CHARGING PROCEDURES
- ASH HANDLING PROCEDURES
- STARTUP/SHUTDOWN PROCEDURES

SLIDE 6-4

KEY OPERATING PARAMETERS FOR CONTROLLED-AIR INCINERATORS

- CHARGING RATE
- PRIMARY CHAMBER TEMPERATURE
- SECONDARY CHAMBER TEMPERATURE
- COMBUSTION CHAMBER DRAFT
- PRIMARY CHAMBER COMBUSTION AIR LEVEL
- TOTAL COMBUSTION AIR LEVEL
- COMBUSTION GAS OXYGEN CONCENTRATION

SLIDE 6-5

KEY OPERATING PARAMETER--WASTE CHARGING RATE

OPERATING RANGE:

- HEAT INPUT CONSISTENT WITH DESIGN
- SINGLE BATCH OPERATION
  - -- FILL CHAMBER; DO NOT OVERFILL
- INTERMITTENT AND CONTINUOUS DUTY
  - -- SMALL BATCHES AT FREQUENT INTERVALS
  - -- 10 TO 25 PERCENT RATED CAPACITY AT 5 TO 15 MINUTES

FACTORS:

- WASTE PROPERTIES
- OPERATING MODE OF INCINERATOR

SLIDE 6-6

KEY OPERATING PARAMETER--WASTE CHARGING RATE

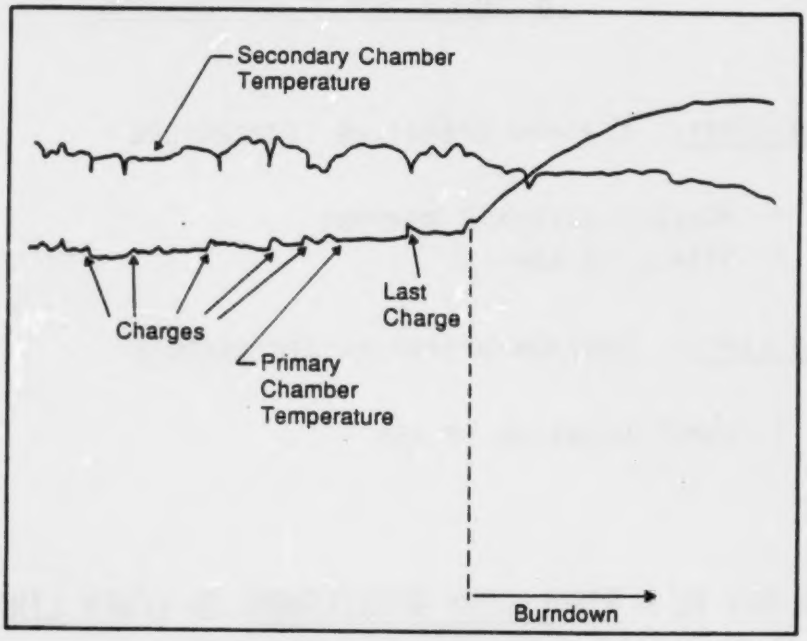
OPERATOR MONITORS:

- CHARGE RATE, LB/H
  - -- AMOUNT AND FREQUENCY OF CHARGE
- ASH BED
  - -- BUILDUP
- ASH QUALITY
  - -- "GOOD" BURNOUT
- TEMPERATURE TRENDS
  - -- LOW TEMPERATURE--CHARGE NEEDED?
  - -- HIGH SECONDARY TEMPERATURE--WAIT?

CONTROL BY:

- SMALLER OR LARGER BATCHES
- LESS OR MORE FREQUENT CHARGES

SLIDE 6-7



TEMPERATURE TREND[1]

PRIMARY CHAMBER TEMPERATURE

LOWER LIMIT: MINIMUM OPERATING TEMPERATURE

- ACHIEVE ADEQUATE BURNOUT
- STERILIZE ASH

UPPER LIMIT: MAXIMUM OPERATING TEMPERATURE

- LIMIT SLAGGING OF ASH

THERE MAY BE A REGULATORY REQUIREMENT ON LOWER LIMIT

SLIDE 6-9

KEY OPERATING PARAMETER--PRIMARY CHAMBER TEMPERATURE

RECOMMENDED OPERATING RANGE:

- BATCH - 1000° TO 1800°F
- INTERMITTENT - 1000° TO 1800°F
- CONTINUOUS - 1400° TO 1800°F

OPERATOR MONITORS

- TEMPERATURE READING
- TEMPERATURE TREND

CONTROL BY:

- ADJUSTING CHARGING RATE
- ADJUSTING PRIMARY COMBUSTION AIR LEVEL
- AUXILIARY BURNER OPERATION

SLIDE 6-10

SECONDARY CHAMBER TEMPERATURE

LOWER LIMIT: MINIMUM OPERATING TEMPERATURE

- HIGH ENOUGH TEMPERATURE TO COMBUST ALL ORGANIC COMPOUNDS

UPPER LIMIT: MAXIMUM TEMPERATURE

- PREVENT DAMAGE TO REFRACTORY

THERE MAY BE A REGULATORY REQUIREMENT ON LOWER LIMIT

SLIDE 6-11

KEY OPERATING PARAMETER--SECONDARY CHAMBER TEMPERATURE

RECOMMENDED OPERATING RANGE:

- 1800° TO 2200°

OPERATOR MONITORS:

- TEMPERATURE READING
- TEMPERATURE TREND

CONTROL BY:

- ADJUSTING SECONDARY COMBUSTION AIR LEVEL
- SECONDARY BURNER OPERATION
- ADJUSTING PRIMARY CHAMBER PARAMETERS
- ADJUSTING CHARGING RATE

SLIDE 6-12

PRIMARY CHAMBER COMBUSTION AIR LEVEL

- CONTROLS COMBUSTION RATE AND TEMPERATURE IN PRIMARY CHAMBER
- CONTROLS RELEASE RATE OF COMBUSTIBLE GASES TO SECONDARY CHAMBER
- MAINTAINED BELOW STOICHIOMETRIC

SLIDE 6-13

KEY OPERATING PARAMETER--PRIMARY CHAMBER COMBUSTION AIR

RECOMMENDED OPERATING RANGE:

- 30 TO 80 PERCENT OF STOICHIOMETRIC

MONITOR:

- VISUAL OBSERVATION
  -- DARK RED SMOKEY COMBUSTION ZONE
- PRIMARY CHAMBER TEMPERATURE

CONTROL BY:

- INCREASE/DECREASE COMBUSTION AIRFLOW

SLIDE 6-14

SECONDARY CHAMBER AND TOTAL COMBUSTION AIR LEVEL

- CONTROLS TEMPERATURE OF SECONDARY CHAMBER
- EXCESS AIR ASSURES SUFFICIENT OXYGEN FOR COMPLETE COMBUSTION

KEY OPERATING PARAMETER--TOTAL COMBUSTION AIR LEVEL

RECOMMENDED OPERATING RANGE:

- 140 TO 200 PERCENT EXCESS AIR

MONITORING:

- SECONDARY COMBUSTION CHAMBER TEMPERATURE
- STACK GAS OPACITY
  - -- BLACK SMOKE → DEFICIENT AIR
- COMBUSTION GAS OXYGEN LEVEL

CONTROL BY:

- ADJUSTING SECONDARY AIRFLOW

SLIDE 6-16

COMBUSTION CHAMBER DRAFT

- PREVENT EXCESSIVE PARTICULATE MATTER ENTRAINMENT
- PREVENT AIR OUT-LEAKAGE

Slide 6-17

KEY OPERATING PARAMETER--COMBUSTION CHAMBER DRAFT

Recommended range:

- Negative 0.05 to 0.1 inches water

Monitor:

- Draft gauge

Control by:

- Natural draft damper setting
  -- Barometric, automatic, manual
- Fan damper setting

SLIDE 6-18

OTHER PARAMETERS TO MONITOR

STACK GAS OPACITY

- EASY TO DO
- INDICATOR OF PARTICULATE EMISSION/POOR COMBUSTION
- ADJUST SECONDARY AIR OR CHARGE RATE
- CHECK SECONDARY BURNER

OTHER PARAMETERS TO MONITOR

ASH QUALITY

- EASY TO DO
- PIECES OF UNBURNED WASTE NOT GOOD
- GRAY COLOR BETTER THAN BLACK
- INCREASE PRIMARY TEMPERATURE
- DECREASE CHARGE RATE
- INCREASE BURNOUT TIME

OTHER PARAMETERS TO MONITOR

STACK GAS CARBON MONOXIDE

- INDICATOR OF COMBUSTION EFFICIENCY
- NEED INSTRUMENT
- SHOULD BE <100 PPM

Slide 6-21

OTHER PARAMETERS TO MONITOR

Secondary burner flame pattern

- Bright yellow/orange
- No smoke
- No impingement

Slide 6-22

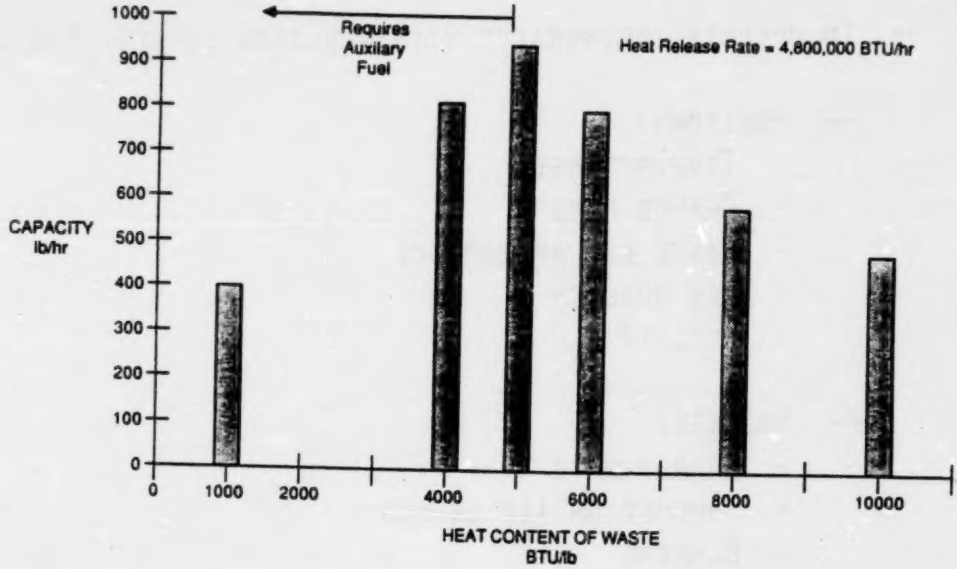
CONTROL AND MONITORING SUMMARY

- Waste composition, charge rate, temperatures, air levels are all interrelated
- Within limits of design--automatic control system adjusts air level to control heat release and temperature
- Operator can control charge rate

CONTROL AND MONITORING SUMMARY (CONTINUED)

- TO OPERATE INCINERATOR WITHIN DESIGN LIMITS, THE OPERATOR
  - MONITORS:
    - TEMPERATURES
    - CHARGE RATE
    - WASTE BED APPEARANCE
    - ASH QUALITY
    - OPACITY
  - ADJUSTS:
    - CHARGE RATE
    - COMBUSTION AIR LEVELS
    - BURNERS

SLIDE 6-24



INCINERATOR CAPACITY VERSUS HEAT CONTENT OF WASTE

SLIDE 6-25

PROPER WASTE CHARGING PROCEDURES

SINGLE BATCH OPERATION

- CHARGE INCINERATOR COLD
- DO NOT "STUFF" INCINERATOR
- CLOSE AND SEAL DOOR BEFORE IGNITION
- PREHEAT SECONDARY CHAMBER BEFORE IGNITION
- DECREASE SIZE OF LOAD, AS NECESSARY, TO PREVENT EMISSIONS AT STARTUP

SLIDE 6-26

PROPER WASTE CHARGING PROCEDURES

INTERMITTENT DUTY AND CONTINUOUS DUTY

- MORE FREQUENT SMALLER CHARGES ARE BETTER THAN ONE LARGE CHARGE
- ADJUST CHARGE VOLUME AND FREQUENCY TO ACCOUNT FOR WASTE VARIATIONS

SLIDE 6-27

PATHOLOGICAL WASTES

- LIMIT AMOUNT OF PATHOLOGICAL WASTE IF INCINERATOR IS NOT A PATHOLOGICAL DESIGN
- OPERATE PRIMARY BURNERS DURING INCINERATION
- CHARGE WASTE TO HEARTH IN SHALLOW LAYER
  - -- DO NOT PILE
  - -- EXPOSE TO FLAME

SLIDE 6-28

PROPER ASH HANDLING PROCEDURES

SINGLE BATCH/INTERMITTENT OPERATION

- ALLOW INCINERATOR TO COOL
- DO NOT SPRAY WATER INTO COMBUSTION CHAMBER
- USE FLAT/BLUNT TOOL FOR ASH REMOVAL
- AVOID PUSHING ASH INTO UNDERFIRE PORTS
- PLACE ASH IN METAL CONTAINER
- DAMPEN ASH TO PREVENT FUGITIVE DUST
- PROPERLY DISPOSE OF ASH
- MAKE SURE ASH DOOR IS PROPERLY SEALED
- INSPECT ASH QUALITY;
  MAKE CORRECTIONS TO OPERATION, IF NECESSARY

SLIDE 6-29

PROPER ASH HANDLING PROCEDURES

CONTINUOUS DUTY

- WATCH FOR JAMS IN CONVEYOR SYSTEMS
- ASSURE QUENCH WATER FLOW IS ADEQUATE
- REPLACE FULL ASH CONTAINER WITH EMPTY CONTAINER
- KEEP ASH WET OR COVER TO PREVENT FUGITIVE DUST
- INSPECT ASH QUALITY
  ADJUST INCINERATOR OPERATION, IF NECESSARY

STARTUP AND SHUTDOWN

SINGLE BATCH UNIT

STARTUP:

- CHARGE INCINERATOR COLD
- PREHEAT THE SECONDARY CHAMBER BEFORE IGNITING WASTE

SHUTDOWN:

- INCREASE PRIMARY COMBUSTION CHAMBER AIR TO PROMOTE COMBUSTION OF FIXED CARBON
- AFTER PRIMARY TEMPERATURE DECREASES TO PRESET LEVEL, SHUT DOWN SECONDARY BURNER
- KEEP COMBUSTION BLOWERS OPERATING TO COOL INCINERATOR
- REMOVE ASH AFTER INCINERATOR COOLS

SLIDE 6-31

STARTUP AND SHUTDOWN

INTERMITTENT AND CONTINUOUS DUTY

STARTUP:

- PREHEAT SECONDARY CHAMBER BEFORE INITIATING CHARGING
- CHARGE WASTE
- IGNITE WASTE

SHUTDOWN:

- INTERMITTENT DUTY--SAME AS BATCH
- CONTINUOUS DUTY
  - -- STOP CHARGING SYSTEM
  - -- MAINTAIN OPERATION OF INCINERATOR AND ASH SYSTEM UNTIL ALL WASTE IS DISCHARGED FROM INCINERATOR
  - -- SHUTDOWN INCINERATOR

Slide 6-32

OPERATOR'S LOG

- Written log book
- Record significant events
  - -- Startup/shutdown
  - -- Adjustments
  - -- Changes in charge rate
- Record unusual problems and corrective actions

SLIDE 6-33

DO

- PAY CAREFUL ATTENTION TO CHARGING RATE
  - -- ADJUST CHARGING RATE, IF NECESSARY
- MONITOR COMBUSTION TEMPERATURES
  - -- LEARN TO RECOGNIZE TRENDS
- MONITOR STACK OPACITY
- INSPECT THE CHAMBERS THROUGH VIEWPORTS
- INSPECT ASH QUALITY
  - -- ADJUST OPERATION, IF NECESSARY
- PROPERLY HANDLE AND DISPOSE OF ASH
- PREHEAT THE SECONDARY CHAMBER BEFORE STARTUP
- KEEP AN OPERATING LOG

SLIDE 6-34

DON'T

- IGNORE PROBLEMS INDICATED BY MONITORS
- OVERCHARGE THE INCINERATOR

KEY OPERATING PARAMETERS:
MULTIPLE-CHAMBER, EXCESS-AIR INCINERATORS

Parameter	Recommended operating range
Waste charge rate	
--Red bag	10-25% of rated capacity at 10-15 minute intervals
--Pathological	Single layer on hearth

Slide 6-36

KEY OPERATING PARAMETERS: MULTIPLE-CHAMBER, EXCESS-AIR INCINERATORS

Parameter	Recommended operating range
Primary chamber temperature	
--General refuse	1000°-1400°F
--Pathological	1600°-1800°F
Secondary chamber temperature	1800°-2200°F

KEY OPERATING PARAMETERS: MULTIPLE-CHAMBER, EXCESS-AIR INCINERATORS

PARAMETER	RECOMMENDED OPERATING RANGE
PRIMARY CHAMBER COMBUSTION AIR	80-150% EXCESS AIR
TOTAL COMBUSTION AIR	120 TO 300% EXCESS AIR
COMBUSTION GAS OXYGEN CON.	10-16%
COMBUSTION CHAMBER DRAFT	NEGATIVE 0.05 TO 0.1 IN. W.C.

SLIDE 6-38

SUMMARY OF OPERATION

- UNITS ARE BATCH OR INTERMITTENT DUTY
- PRIMARY CHAMBER IS EXCESS AIR ATMOSPHERE
  - -- HEAT RELEASE RATE IS CONTROLLED BY CHARGE RATE AND BURNERS
  - -- FOR PATHOLOGICAL WASTE HEAT RELEASE RATE IS CONTROLLED BY PRIMARY BURNERS

SLIDE 6-39

SUMMARY OF MONITORING AND CONTROL

OPERATOR MONITORS:

- CHARGING RATE
- TEMPERATURES OF BOTH CHAMBERS
- TEMPERATURE TRENDS
- DRAFT
- ASH BED APPEARANCE
- ASH QUALITY
- OPACITY

SLIDE 6-40

SUMMARY OF MONITORING AND CONTROL

OPERATOR CONTROLS:

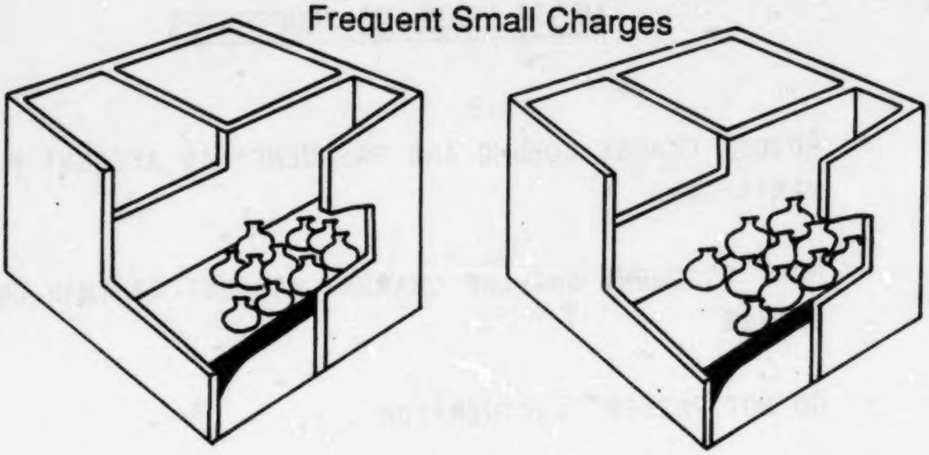
- CHARGE RATE
- AIR DAMPER SETTINGS
- AUXILIARY BURNER OPERATION

Slide 6-41

WASTE CHARGING PROCEDURES

- Adjust charge volume and frequency to account for waste variations
- More frequent smaller charges are better than one large charge
- Do not "stuff" incinerator
- Assure primary burner is off prior to charging
- Gently push old waste to back of hearth; charge new waste at front of hearth

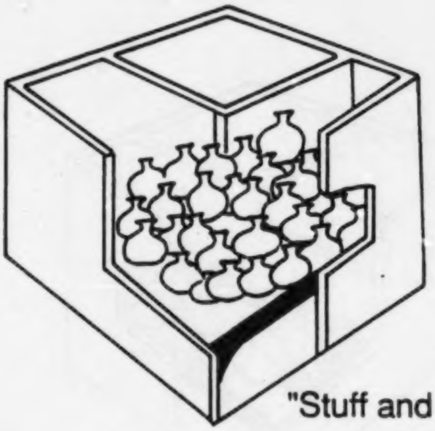
SLIDE 6-42



Frequent Small Charges

PROPER CHARGE PROCEDURES

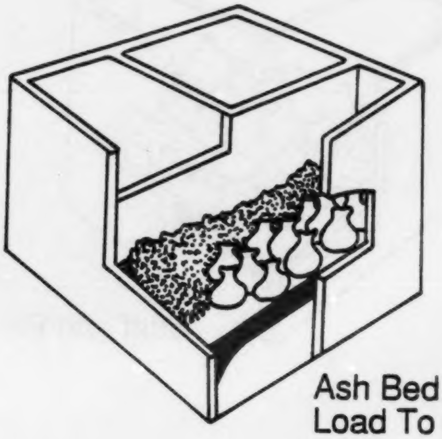
SLIDE 6-43



"Stuff and Burn"

IMPROPER CHARGE PROCEDURES

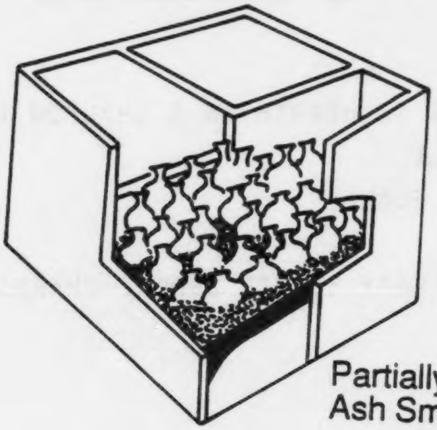
SLIDE 6-44



Ash Bed Stoked To Rear;
Load To Front

PROPER LOADING ON HEARTH

SLIDE 6-45


Partially Burned
Ash Smothered

IMPROPER LOADING ON HEARTH

Slide 6-46

PATHOLOGICAL WASTES

- Charge waste to hearth in a shallow layer
  --Do not pile
  --Expose to flame
- Turn off primary burner before charging

SLIDE 6-47

PROPER ASH HANDLING PROCEDURES

- ALLOW INCINERATOR TO COOL
- DO NOT SPRAY WATER INTO COMBUSTION CHAMBER
- USE FLAT/BLUNT TOOL FOR ASH REMOVAL
- PLACE ASH IN METAL CONTAINER
- DAMPEN ASH TO PREVENT FUGITIVE DUST
- PROPERLY DISPOSE OF ASH
- INSPECT ASH QUALITY; MAKE CORRECTIONS IN OPERATION, IF NECESSARY

SLIDE 6-48

STARTUP AND SHUTDOWN

STARTUP:

- PREHEAT SECONDARY CHAMBER BEFORE INITIATING CHARGING
- CHARGE WASTE
- IGNITE WASTE

SHUTDOWN:

- SHUT DOWN BURNERS
- ALLOW INCINERATOR TO COOL
- REMOVE ASH

SLIDE 6-49

DO

- PREHEAT THE SECONDARY CHAMBER
- PAY CAREFUL ATTENTION TO CHARGING PROCEDURES AND RATES
- SHUT OFF PRIMARY BURNER WHEN CHARGING
- MONITOR COMBUSTION CHAMBER TEMPERATURES
- MONITOR COMBUSTION CHAMBER DRAFT
- MONITOR STACK GAS OPACITY--ESPECIALLY AFTER CHARGING
- INSPECT ASH QUALITY
- FOR PATHOLOGICAL WASTES, OPERATE PRIMARY BURNER AT ALL TIMES

SLIDE 6-50

DON'T

- OVERCHARGE THE INCINERATOR
- DEEPLY PILE PATHOLOGICAL WASTE ON THE HEARTH

SESSION 7.

AIR POLLUTION CONTROL SYSTEMS OPERATION

SLIDE 7-1

AIR POLLUTION CONTROL SYSTEMS FOR HOSPITAL INCINERATORS

- WET SCRUBBERS
  - -- SPRAY TOWERS
  - -- VENTURI SCRUBBERS
  - -- PACKED-BED SCRUBBERS

- FABRIC FILTERS

- DRY SCRUBBERS
  - -- DRY INJECTION
  - -- SPRAY DRYERS

- ELECTROSTATIC PRECIPITATORS

SLIDE 7-2

RECOMMENDED OPERATING RANGES FOR KEY PARAMETERS

VENTURI SCRUBBER

PARAMETER	RANGE
• PRESSURE DROP	20-30 IN. W.C.
• LIQUID SUPPLY	7-10 GAL/1,000 ACF
• pH	5.5-7.0
• SUSPENDED SOLIDS	0-3 PERCENT

SLIDE 7-3

VENTURI SCRUBBER PARAMETERS USUALLY MONITORED BY OPERATOR

- PRESSURE DROP
- LIQUID FLOW RATE
- pH
- FAN
  - STATIC PRESSURE
  - RPM
  - AMPERAGE

Slide 7-4

VENTURI SCRUBBER OPERATION

Key parameter	Adjustment
Pressure drop	Variable throat Fan damper Fan speed
Liquid supply	Liquid flow rate
Suspended solids	Makeup water Blowdown
pH	Makeup caustic

SLIDE 7-5

VENTURI SCRUBBER STARTUP SEQUENCE

1. TURN ON LIQUID SUPPLY AND RECIRCULATION
2. SET LIQUID FLOW TO MANUFACTURER SPECIFICATIONS
3. CLOSE FAN DAMPER
4. START FAN
5. GRADUALLY OPEN DAMPER
6. ADJUST LIQUID FLOW TO OBTAIN DESIRED LIQUID SUPPLY
7. ADJUST VENTURI THROAT, FAN AMPERAGE, OR DAMPER TO OBTAIN DESIRED PRESSURE DROP
8. ADJUST BLOWDOWN

SLIDE 7-6

VENTURI SCRUBBER SHUTDOWN SEQUENCE

1. SHUT OFF SCRUBBER FAN
2. SHUT OFF RECIRCULATION
3. SHUT OFF MAKEUP WATER

RECOMMENDED OPERATING RANGES FOR KEY PARAMETERS

PACKED-BED SCRUBBER

Parameter	Range
• Liquid supply	15-25 gal/1,000 acf
• pH	5.5-7.0
• Suspended solids	0-3 percent
• Inlet gas temperature	Specified by manufacturer
• Pressure drop	1-5 in. w.c.

SLIDE 7-8

PACKED-BED SCRUBBER PARAMETERS USUALLY MONITORED BY OPERATOR

- LIQUID FLOW RATE
- PRESSURE DROP
- INLET GAS TEMPERATURE
- pH
- FAN
  - -- STATIC PRESSURE
  - -- RPM
  - -- AMPERAGE

PACKED-BED SCRUBBER OPERATION

KEY PARAMETER	ADJUSTMENT
LIQUID SUPPLY	LIQUID FLOW RATE
pH	CAUSTIC FEED RATE
SUSPENDED SOLIDS	MAKEUP WATER BLOWDOWN
INLET GAS TEMPERATURE	INCINERATOR EXHAUST TEMPERATURE PREQUENCH

SLIDE 7-10

RECOMMENDED OPERATING RANGES FOR KEY PARAMETERS

SPRAY TOWER

• LIQUID SUPPLY	5 TO 20 GAL/1,000 ACF
• PRESSURE DROP	1 TO 3 IN. W.C.

RECOMMENDED OPERATING RANGES FOR KEY PARAMETERS

PULSE-JET FABRIC FILTER

Parameter	Range
Flue gas temperature:	
Upper limit	Specified by manufacturer
Lower limit	Above dewpoint
Pressure drop	5-9 in. w.c.
Cleaning air pressure	60-100 psig

SLIDE 7-12

FABRIC FILTER PARAMETERS USUALLY MONITORED BY OPERATOR

- OPACITY
- PRESSURE DROP
- INLET GAS TEMPERATURE
- OUTLET GAS TEMPERATURE

Slide 7-13

FABRIC FILTER OPERATION

Key parameter	Adjustment
Flue gas temperature:	
Upper limit	Bypass fabric filter Lower incinerator (Boiler) exhaust temperature Introduce cool ambient air
Lower limit	Increase auxiliary fuel
Pressure drop	Bag cleaning frequency
Cleaning air pressure	Compressed air system

SLIDE 7-14

FABRIC FILTER STARTUP

- PRECOAT BAGS
- USE AUXILIARY FUEL-FIRING TO BRING SYSTEM TO OPERATING TEMPERATURE
- GRADUALLY BUILDUP DUST CAKE

Slide 7-15

FABRIC FILTER SHUTDOWN

- Stop waste charging
- Maintain secondary chamber burner firing until waste is combusted
- Shut off incinerator
- Purge remaining combustion products
- Clean bags

SLIDE 7-16

RECOMMENDED OPERATING RANGES FOR KEY PARAMETERS

DRY INJECTION

PARAMETER	RANGE
• SORBENT INJECTION RATE	SPECIFIED BY MANUFACTURER
• SORBENT PARTICLE SIZE	90 PERCENT BY WEIGHT THROUGH 325 MESH SCREEN

SLIDE 7-17

RECOMMENDED OPERATING RANGES FOR KEY PARAMETERS

SPRAY DRYERS

PARAMETER	RANGE
• SLURRY SORBENT CONTENT	5-20 PERCENT
• WET BULB/DRY BULB TEMPERATURE DIFFERENCE	90° TO 180°F

SLIDE 7-18

SPRAY DRYER OPERATION

KEY PARAMETER	ADJUSTMENT
SLURRY SORBENT CONTENT	DRY SORBENT/WATER RATIO
WET BULB/DRY BULB TEMPERATURE DIFFERENCE	SLURRY FLOW RATE

SPRAY DRYER STARTUP/SHUTDOWN

STARTUP ALTERNATIVES:

1. USE AUXILIARY FUEL-FIRING TO BRING SYSTEM UP TO OPERATING TEMPERATURE BEFORE INJECTING SLURRY

2. GRADUALLY INCREASE SLURRY FEED AS EXHAUST TEMPERATURE INCREASES TO MAINTAIN 90° TO 180°F WET BULB/DRY BULB DIFFERENCE

SHUTDOWN:

1. USE AUXILIARY FUEL-FIRING TO MAINTAIN TEMPERATURE ABOVE SATURATION UNTIL ALL WASTE IS COMBUSTED

2. SHUT OFF SPRAY DRYER

SLIDE 7-20

RECOMMENDED OPERATING RANGES FOR KEY PARAMETERS

ELECTROSTATIC PRECIPITATORS

PARAMETER	RANGE
INLET GAS TEMPERATURE	
-- HOT SIDE ESP	570° TO 800°F
-- COLD SIDE ESP	<400°F
PARTICULATE RESISTIVITY	10^7 TO 10^{10} OHM-CM
POWER RATIO	0.5 TO 0.9

ESP OPERATION

KEY PARAMETER	ADJUSTMENT
PRIMARY VOLTAGE/CURRENT	POWER SUPPLY
	CLEAN/ADJUST ELECTRODES
SECONDARY VOLTAGE/CURRENT	T/R
	RESISTIVITY
RESISTIVITY	GAS TEMPERATURE
	CONDITIONING AGENT ADDITION
	COMBUSTION/CARBON CONTENT
GAS TEMPERATURE	CONDITION GAS STREAM
	INCINERATOR/BOILER OPERATION

Slide 7-22

ESP STARTUP/SHUTDOWN

Startup

- Check hopper/ash handling operation
- Preheat hoppers
- Set rapper cycle
- Check rapper operation
- Check T/R setting
- Sequentially energize T/R by field

Shutdown

- Shutdown incinerator
- Deenergize T/R by field
- After 4 hours deenergize heaters
- After 8 hours shutdown rappers

SESSION 8.

MAINTENANCE INSPECTION--A NECESSARY PART OF YOUR JOB

SLIDE 8-1

PREVENTIVE MAINTENANCE

- PROGRAM TO CONDUCT MAINTENANCE ON REGULAR SCHEDULED BASIS
- RESPONSIBILITY OF MAINTENANCE DEPARTMENT?
- YOU CAN HELP
  - -- INSPECT UNIT
  - -- IDENTIFY MINOR PROBLEMS
  - -- REPORT TO MAINTENANCE DEPARTMENT

Slide 8-2

TYPICAL MAINTENANCE INSPECTION SCHEDULE

Activity frequency	Incinerator component
Hourly	Ash removal conveyor
	Water quench pit
	Ram cooling system
Daily	Stack
	Thermocouples
	Limit switches
	Underfire air ports
	Opacity monitor
	Oxygen monitor
Weekly	Blower intakes
	Induced-draft fans
	Control panels
	Refractory
Monthly	External surface of incinerator and stack
90 day	Shut down and do complete walkthrough (first year)

SLIDE 8-3

TYPICAL MAINTENANCE INSPECTION SCHEDULE FOR A WET SCRUBBER

INSPECTION FREQUENCY	COMPONENT
DAILY	SCRUBBER LIQUID PUMP
	VARIABLE THROAT ACTIVATOR
	SCRUBBER LIQUID LINES
	REAGENT FEED SYSTEM
	FAN
	pH METER
	ΔP METER
MONTHLY	DUCT WORK

SLIDE 8-4

TYPICAL MAINTENANCE INSPECTION SCHEDULE FOR A FABRIC FILTER SYSTEM

INSPECTION FREQUENCY	COMPONENT
DAILY	STACK
	MANOMETER
	COMPRESSED AIR SYSTEM
	COLLECTOR/CLEAN CYCLE
	HOPPERS/DUST REMOVAL SYSTEM
	FAN

RECORDKEEPING

- RECORDS ALLOW TRENDS TO BE TRACKED
- ASSISTS WITH EVALUATING PM PROGRAM
- ASSISTS INVENTORY DECISIONS

SLIDE 8-6

DAILY MAINTENANCE INSPECTION LOG

Facility name: ______________________________

Operator's name: ______________________________

Date: ______________________________

Time	Equipment inspected	Notes
	Ash removal conveyor	
	Water quench pit	
	Opacity monitor	
	Oxygen monitor	
	Underfire air ports	
	Ash pit/dropout sump	
	Stack	
	Scrubber liquid pump	
	Variable throat activator	
	Scrubber liquid lines	
	Mist eliminator pressure lines	
	Reagent feed system	
	Fan	
	Fan belt	

SESSION 9.

TYPICAL PROBLEMS

SLIDE 9-1

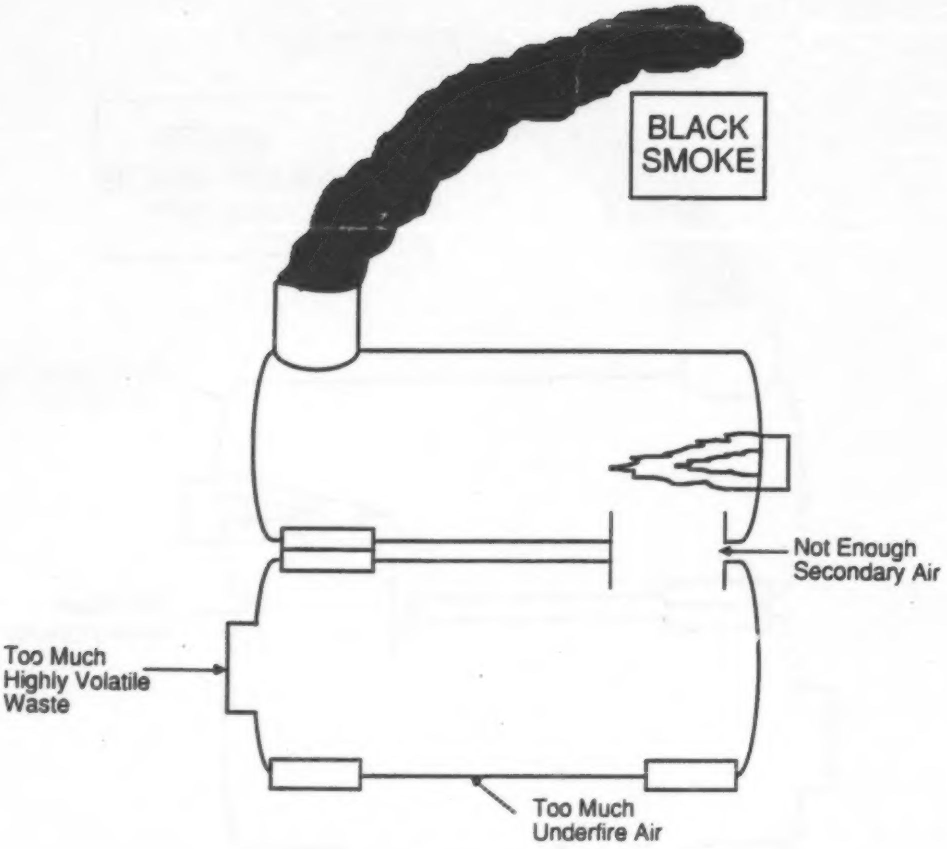
PROBLEMS

IT'S BETTER TO PREVENT PROBLEMS
THAN TO CORRECT PROBLEMS

INCINERATOR PROBLEMS

- BLACK SMOKE
- WHITE/BLUE-WHITE SMOKE
- WHITE SMOKE/HAZE
- PUFFING SMOKE FROM CHAMBER
- EXCESSIVE AUXILIARY FUEL USAGE
- POOR ASH QUALITY
- BURNER PROBLEMS

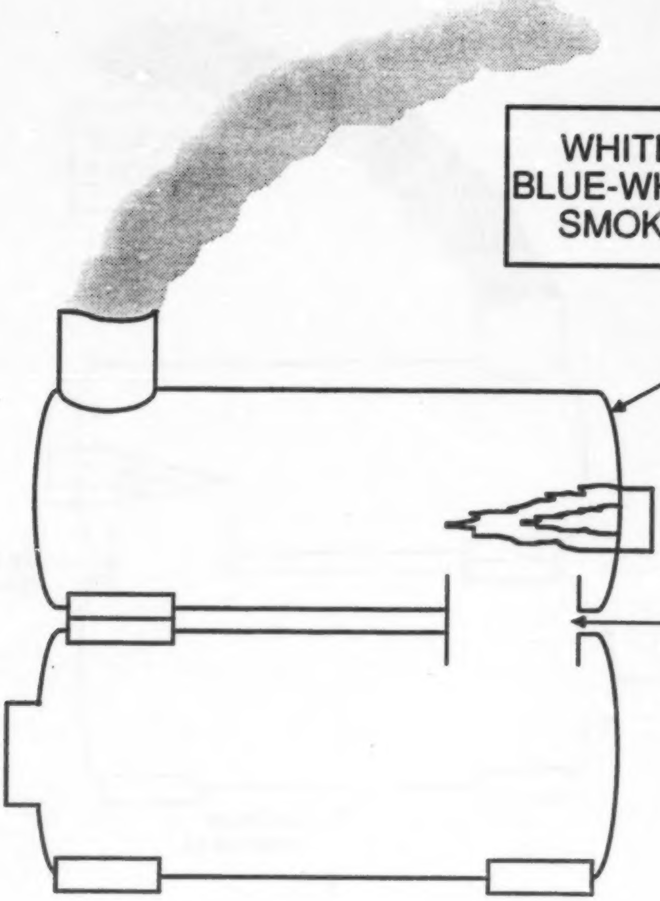
SLIDE 9-3


BLACK SMOKE
Not Enough Secondary Air
Too Much Highly Volatile Waste
Too Much Underfire Air

BLACK SMOKE FROM INCINERATOR STACK

SLIDE 9-4

WHITE/
BLUE-WHITE
SMOKE

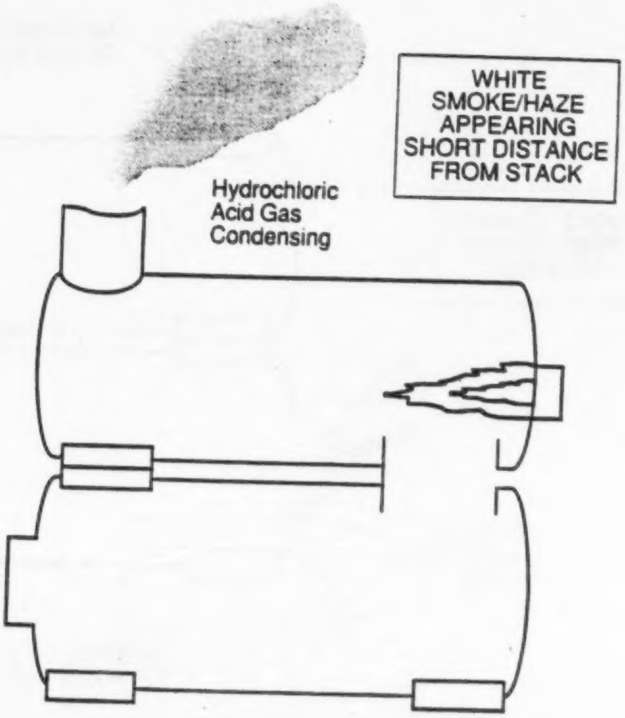


Secondary Chamber
Temperature Too Low

Too Much
Secondary Air

WHITE/BLUE-WHITE SMOKE FROM INCINERATOR STACK

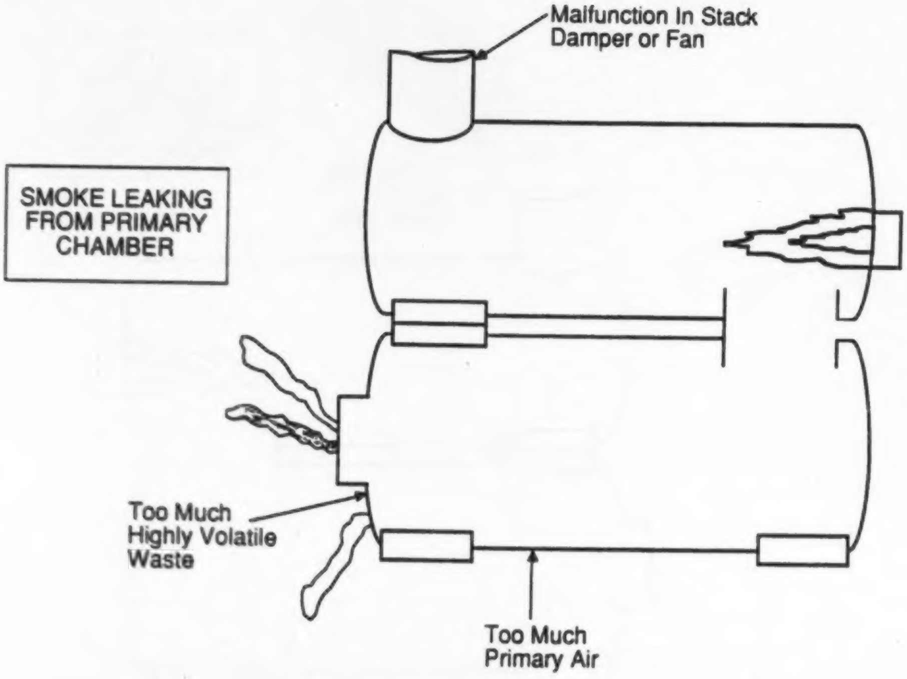
SLIDE 9-5


Hydrochloric
Acid Gas
Condensing

WHITE
SMOKE/HAZE
APPEARING
SHORT DISTANCE
FROM STACK

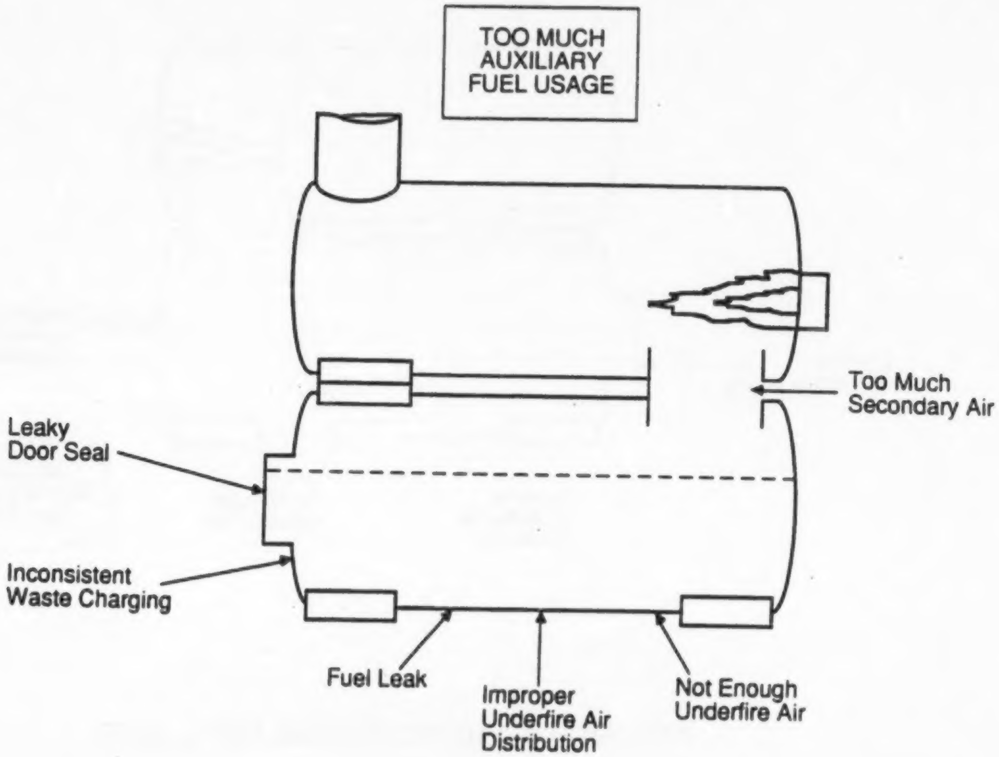
WHITE SMOKE/HAZE A SHORT DISTANCE FROM INCINERATOR STACK

SLIDE 9-6


Malfunction In Stack Damper or Fan
SMOKE LEAKING FROM PRIMARY CHAMBER
Too Much Highly Volatile Waste
Too Much Primary Air

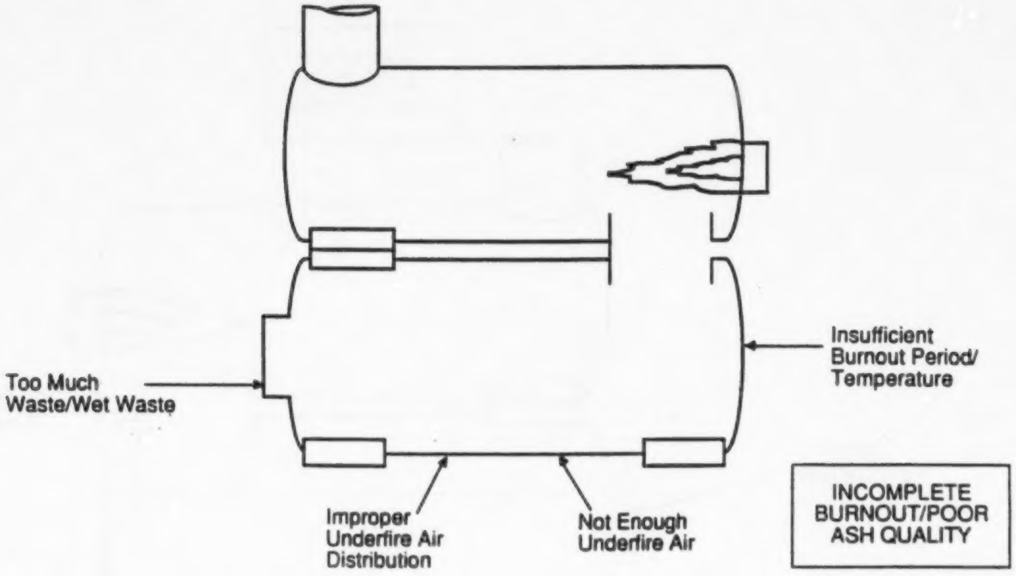
SMOKE LEAVING PRIMARY CHAMBER OF INCINERATOR

SLIDE 9-7


TOO MUCH AUXILIARY FUEL USAGE
Too Much Secondary Air
Leaky Door Seal
Inconsistent Waste Charging
Fuel Leak
Improper Underfire Air Distribution
Not Enough Underfire Air

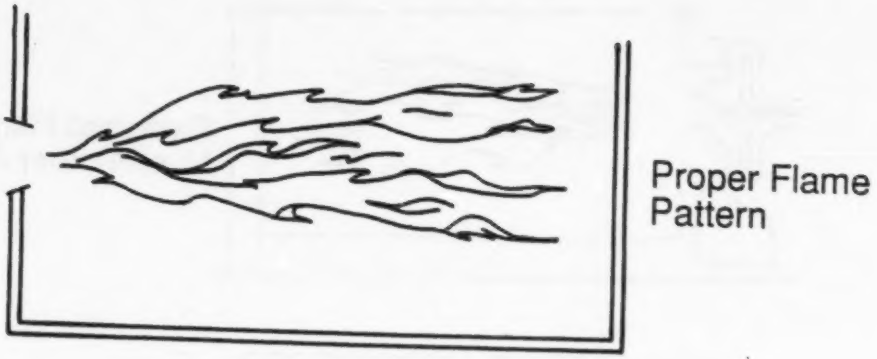
TOO MUCH AUXILARY FUEL USAGE

SLIDE 9-8

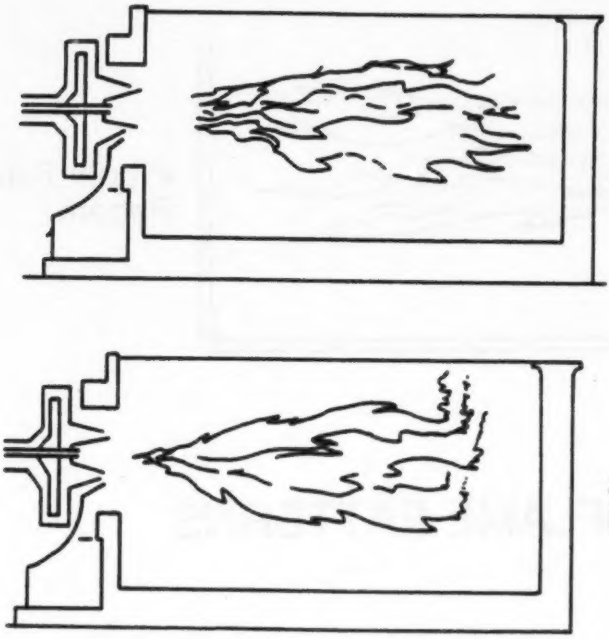

Too Much Waste/Wet Waste
Insufficient Burnout Period/ Temperature
Improper Underfire Air Distribution
Not Enough Underfire Air
INCOMPLETE BURNOUT/POOR ASH QUALITY

INCOMPLETE BURNOUT/POOR ASH QUALITY

SLIDE 9-9


Proper Flame
Pattern

BURNER FLAME PATTERNS [1]

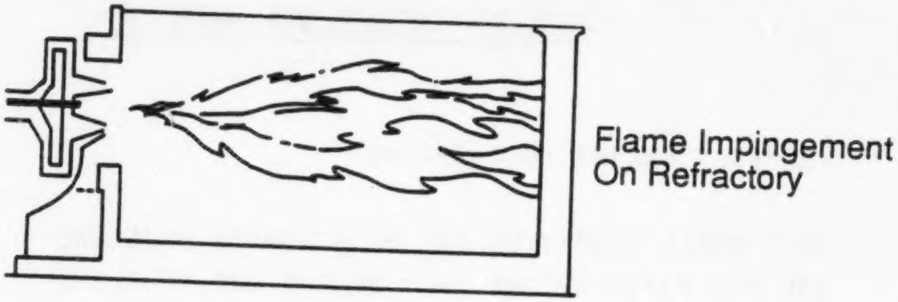


Detached Flame; Too Much Burner Air

Smoking Flame; Not Enough Air

BURNER FLAME PATTERNS [1]

SLIDE 9-11


Flame Impingement
On Refractory

BURNER FLAME PATTERNS[1]

SLIDE 9-12

PREVENT INCINERATOR PROBLEMS

- PROPERLY CHARGE INCINERATOR
- NOTE SMALL OPERATING AND MAINTENANCE PROBLEMS AND GET FIXED BEFORE THEY BECOME BIG PROBLEMS

SLIDE 9-13

WET SCRUBBER PROBLEMS

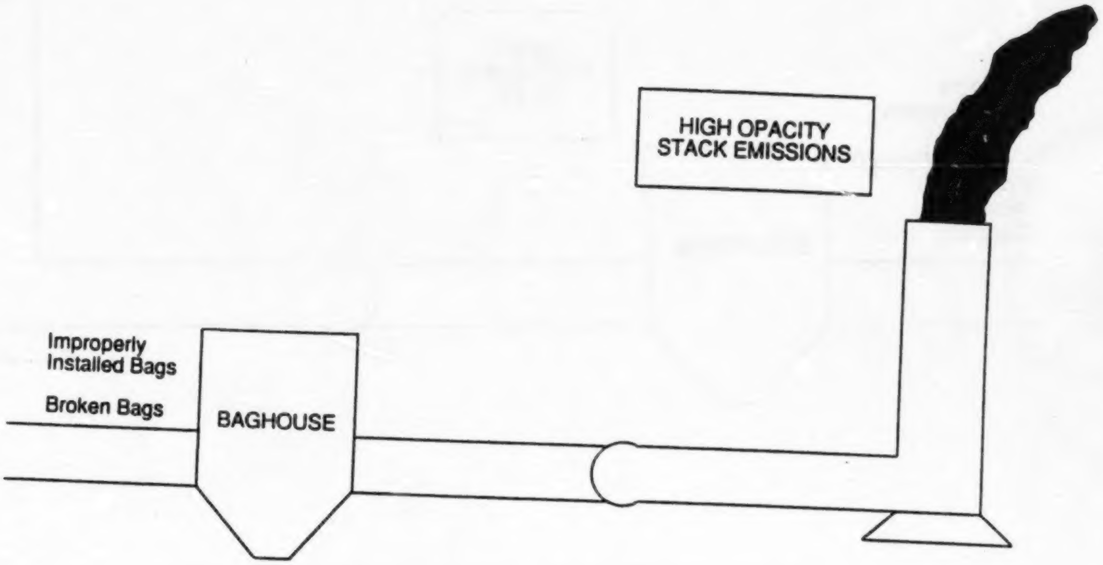
- CORROSION
- PLUGGED SPRAY NOZZLES
- FAN VIBRATION

SLIDE 9-14

PREVENT SCRUBBER PROBLEMS

- MAINTAIN CORRECT pH FOR SCRUBBER LIQUID
- MAINTAIN LOW LEVEL OF SOLIDS IN RECIRCULATED SCRUBBING LIQUID
- USE PREVENTIVE MAINTENANCE PROGRAM FOR INSPECTING/CLEANING NOZZLES, FANS, DAMPERS

SLIDE 9-15



HIGH OPACITY STACK EMISSIONS

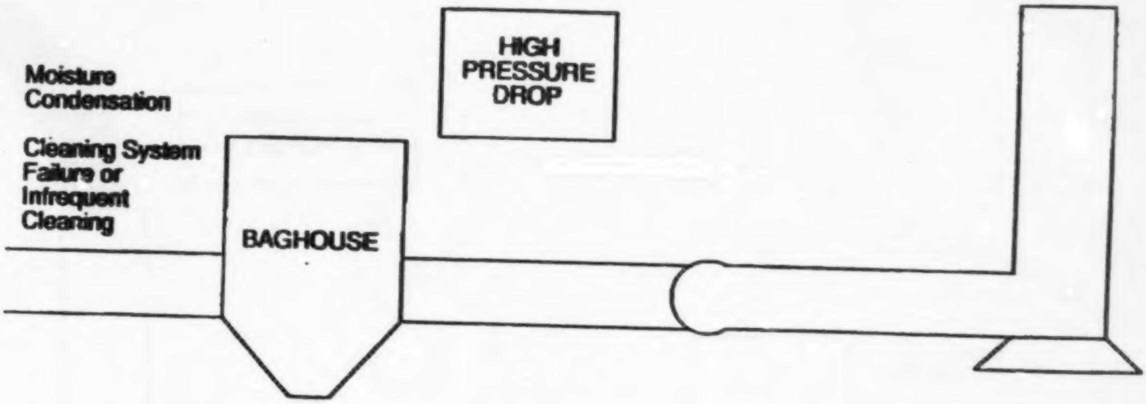
Improperly Installed Bags

Broken Bags

BAGHOUSE

HIGH OPACITY FROM FABRIC FILTER

SLIDE 9-16


Moisture Condensation
Cleaning System Failure or Infrequent Cleaning
BAGHOUSE
HIGH PRESSURE DROP

HIGH PRESSURE DROP IN FABRIC FILTER

SLIDE 9-17

PREVENT FABRIC FILTER PROBLEMS

- MAINTAIN PROPER TEMPERATURE RANGE WITHIN BAGHOUSE
- MONITOR ΔP
- MAINTAIN PROPER CLEANING CYCLE
- MONITOR OPACITY

Slide 9-18

OTHER PROBLEMS

- Water cooling systems for rams
  - --MAINTAIN WATER FLOW
  - --MAINTAIN COOLER OPERATION
- Microswitches
  - --CHECK MOVEMENT BY HAND
  - --LUBRICATE

SLIDE 9-19

WHAT PROBLEMS DO YOU HAVE?

SESSION 10.

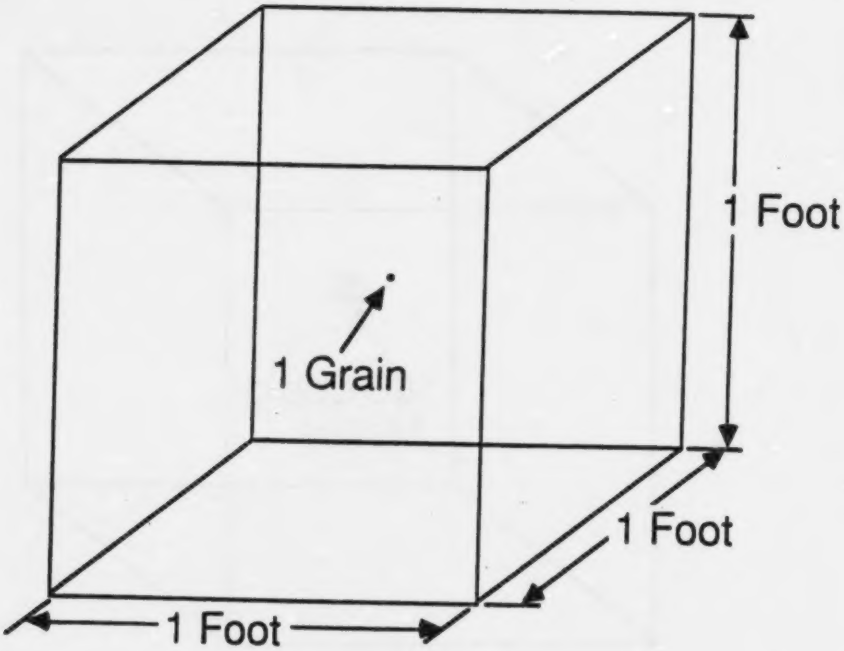
STATE REGULATIONS

SLIDE 10-1

TYPES OF REQUIREMENTS IN STATE REGULATIONS

- EMISSION LIMITS
- OPERATING PRACTICES/LIMITS
- CONTINUOUS EMISSION MONITORING
- RECORDKEEPING AND REPORTING
- OPERATOR TRAINING

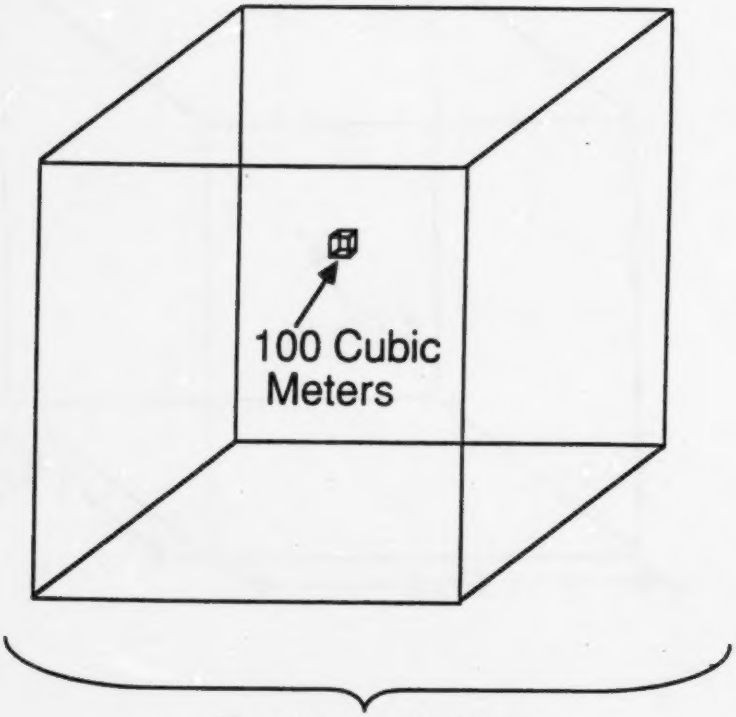
SLIDE 10-2


1 Foot
1 Grain
1 Foot
1 Foot

1 Grain Per Dry Standard
Cubic Foot

7000 Grains=1 pound

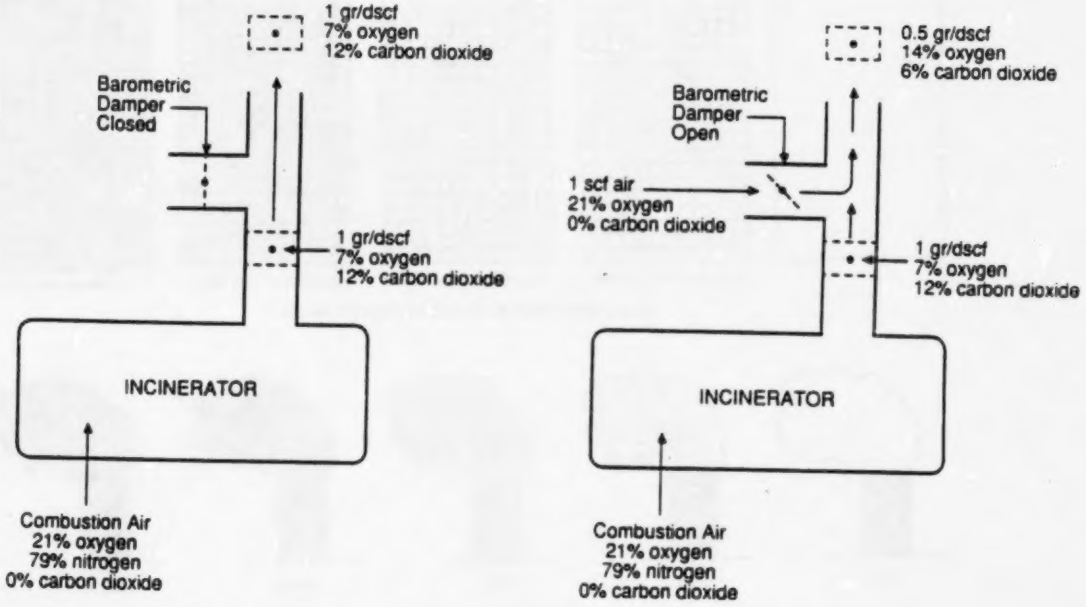
SLIDE 10-3


100 Cubic
Meters

Contains 1 Million
Cubic Meters

100 Parts Per million

SLIDE 10-4

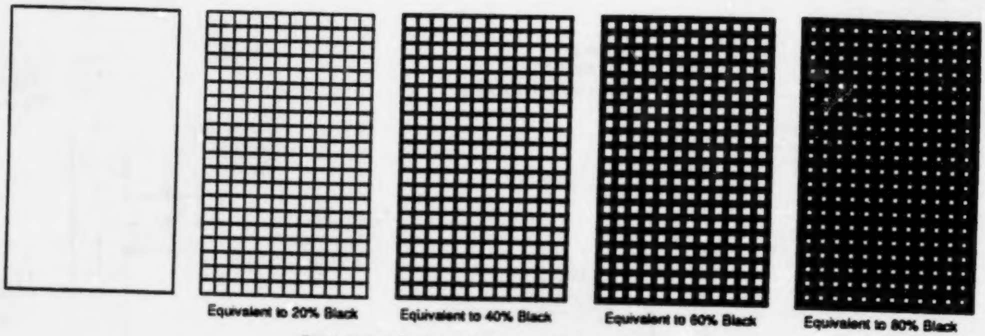

1 gr/dscf
7% oxygen
12% carbon dioxide
Barometric
Damper
Closed
1 gr/dscf
7% oxygen
12% carbon dioxide
INCINERATOR
Combustion Air
21% oxygen
79% nitrogen
0% carbon dioxide
0.5 gr/dscf
14% oxygen
6% carbon dioxide
Barometric
Damper
Open
1 scf air
21% oxygen
0% carbon dioxide
1 gr/dscf
7% oxygen
12% carbon dioxide
INCINERATOR
Combustion Air
21% oxygen
79% nitrogen
0% carbon dioxide

1 gr/dscf @ 7% O_2 = 0.5 gr/dscf @ 14% O_2

1 gr/dscf @ 12% CO_2 = 0.5 gr/dscf @ 6% CO_2

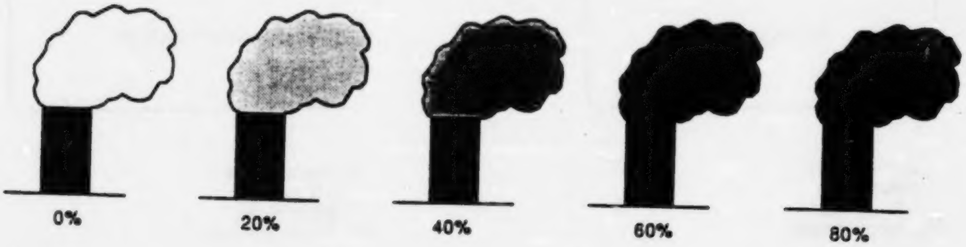
CORRECTION FOR DILUTION

SLIDE 10-5



Equivalent to 20% Black
Equivalent to 40% Black
Equivalent to 60% Black
Equivalent to 80% Black

Ringlemann's Scale for Grading the Density of Smoke

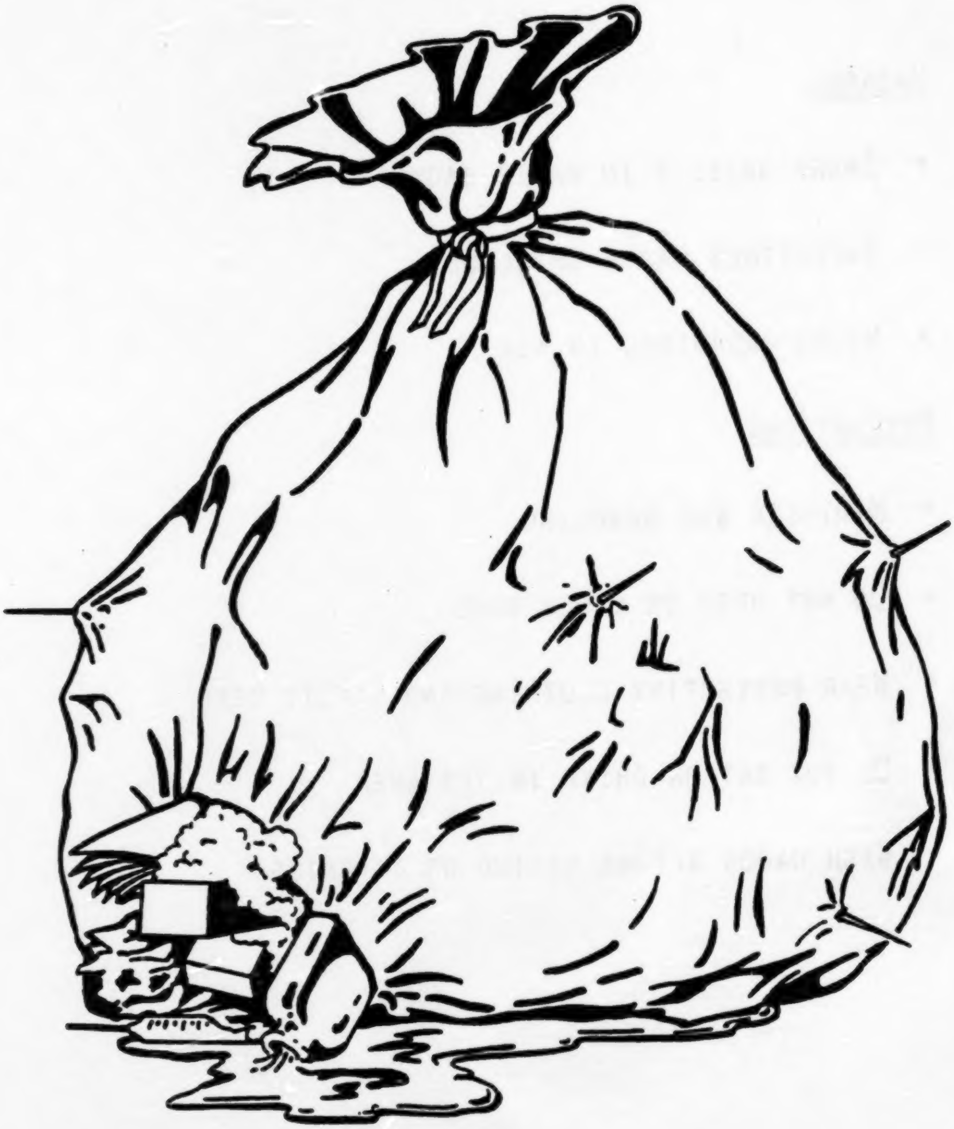


OPACITY AND THE RINGLEMANN CHART

SESSION 11.

SAFETY: AN IMPORTANT PART OF YOUR JOB

Slide 11-1



TORN "RED" BAG

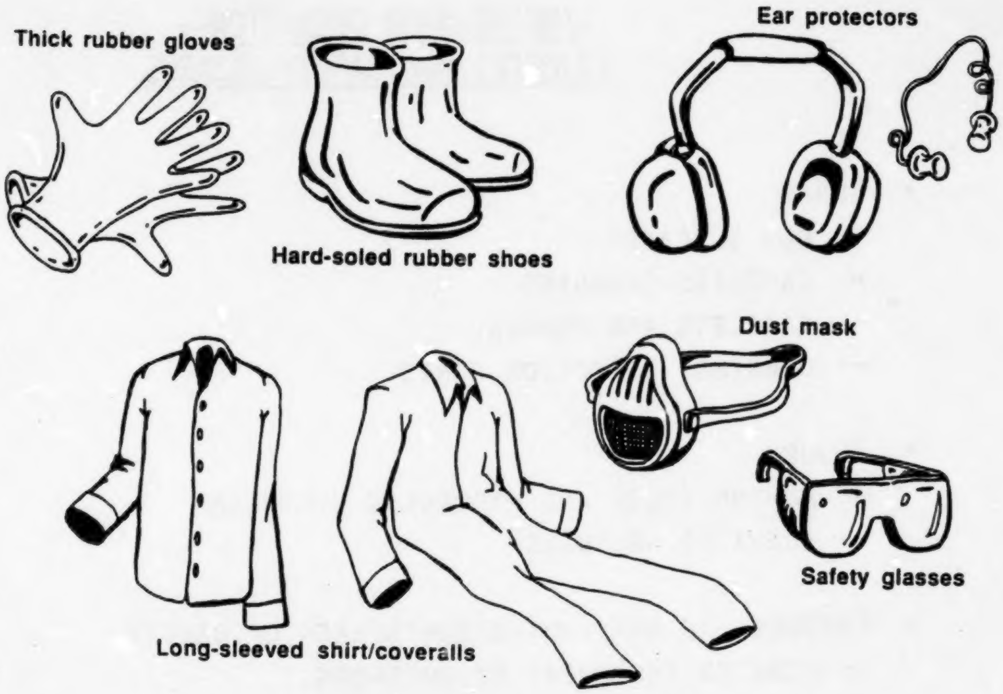
WASTE HANDLING SAFETY

HAZARDS

- SHARP OBJECTS IN WASTE BAGS
- INFECTIOUS WASTE SPILLAGE
- MICRO-ORGANISMS IN AIR

PRECAUTIONS

- MINIMIZE BAG HANDLING
- DO NOT OPEN OR CRUSH BAGS
- WEAR PROTECTIVE CLOTHING AND SAFETY GEAR
- DO NOT EAT OR DRINK IN THE AREA
- WASH HANDS BEFORE EATING OR DRINKING


Thick rubber gloves
Hard-soled rubber shoes
Ear protectors
Dust mask
Safety glasses
Long-sleeved shirt/coveralls

PROPER SAFETY GEAR

SLIDE 11-4

INCINERATOR OPERATION--
INJURIES AND SAFETY HAZARDS

- BURNS
  - -- HOT SURFACES
  - -- CARELESS CHARGING
  - -- CARELESS ASH REMOVAL
  - -- OPENING INSPECTION PORTS
- INJURY
  - -- MOVING BELTS AND HYDRAULIC CYLINDERS
  - -- ELEVATED WALKWAYS
- EXPOSURE TO AIR CONTAMINANTS/LACK OF OXYGEN
  - -- LEAK IN EQUIPMENT OR DUCTWORK
  - -- POOR VENTILATION OF AREA

SLIDE 11-5

BURNER FLAME SAFEGUARD SYSTEM

- CONTROLS BURNER IGNITION
- PURGES SYSTEM
- PILOT IGNITION
  - -- DETECTOR
  - -- 15 SECONDS
  - -- FUEL RELAY
- MAIN BURNER IGNITION
- SHUTDOWN
  - -- FLAME OUT
  - -- AIR SUPPLY FAILURE

SLIDE 11-6

INCINERATOR OPERATION SAFETY PRECAUTIONS

Do's

- WEAR PROTECTIVE CLOTHING AND SAFETY GEAR
- BE CAREFUL AROUND MOVING BELTS, HYDRAULIC CYLINDERS, AND DOORS
- AVOID CONTACT WITH HOT SURFACES
- WATCH FOR FUEL LEAKS
- BE CAREFUL ON ELEVATED WALKWAYS
- VENTILATE ROOM IF THERE IS LACK OF OXYGEN OR UNUSUAL ODORS
- LEAVE AREA IF YOU DEVELOP
  -- HEADACHE, DROWSINESS, SHORTNESS OF BREATH, NAUSEA

SLIDE 11-7

INCINERATOR OPERATION SAFETY PRECAUTIONS

DON'TS

- DO NOT OPEN INSPECTION PORTS DURING OPERATION
- DO NOT PLACE HANDS OR FEET INTO FEED RAM ASSEMBLY OR ASH REMOVAL SYSTEM
- DO NOT LEAN ON GUARDRAILS OF WALKWAYS
- DO NOT BYPASS BURNER FLAME SAFEGUARD SYSTEM

SLIDE 11-8

INCINERATOR OPERATION SAFETY PRECAUTIONS: MANUAL CHARGING

Do's

- WAIT FOR PREVIOUS CHARGE TO BURN DOWN
- TURN OFF PRIMARY CHAMBER BURNER
- STAND BEHIND AND AWAY FROM DOOR

DON'TS

- DO NOT LOOK INTO OPEN CHARGE DOOR
- DO NOT CHARGE BOTTLES OF FLAMMABLE LIQUIDS

SLIDE 11-9

INCINERATOR OPERATION SAFETY PRECAUTIONS: ASH REMOVAL

Do's

- USE PROPER EQUIPMENT TO REMOVE ASH
- WATCH OUT FOR HOT SPOTS AND SHARP OBJECTS
- PUT ASH INTO NONCOMBUSTIBLE CONTAINER
- SPRAY WATER ON ASH IN CONTAINER TO COOL

SLIDE 11-10

INCINERATOR OPERATION SAFETY PRECAUTIONS: ASH REMOVAL

DON'TS

- DO NOT ENTER INCINERATOR CHAMBER
- DO NOT DAMAGE INCINERATOR REFRACTORY
- DO NOT SPRAY WATER INTO CHAMBER
- DO NOT HANDLE ASH DIRECTLY

SLIDE 11-11

WET SCRUBBERS: HAZARDS

- CHEMICAL BURNS
- FALLS
- FAN/FAN BELTS
- HEARING LOSS

SLIDE 11-12

WET SCRUBBERS: SAFETY PRECAUTIONS

Do's

- KEEP SCRUBBER LIQUOR OFF SKIN AND EYES
- LEARN LOCATION OF AND HOW TO USE EYEWASH
- GET SCRUBBER LEAKS REPAIRED
- STAY AWAY FROM FANS, DRIVE SHAFTS, AND FAN BELT ASSEMBLIES
- WEAR EARPLUGS OR EARMUFFS AROUND NOISY EQUIPMENT

WET SCRUBBERS: SAFETY PRECAUTIONS

DON'TS

- DO NOT PLACE HAND IN FAN BELT/PULLEY ASSEMBLY
- DO NOT CONTINUE TO OPERATE IF FAN IS VIBRATING SEVERELY

SLIDE 11-14

FABRIC FILTERS: HAZARDS

- TOXIC CHEMICALS IN FINE DUSTS
- EXCESSIVE HEAT
- FAN/FAN BELTS
- HEARING LOSS
- INSIDE FABRIC FILTER
  - -- TOXIC GASES AND DUST
  - -- HOT, FREE FLOWING SOLIDS
  - -- OXYGEN DEFICIENCY
  - -- ROTATING EQUIPMENT
  - -- MOVING MECHANICAL PARTS

SLIDE 11-15

FABRIC FILTERS: SAFETY PRECAUTIONS

Do's

- PREVENT INHALATION OF DUST BY WEARING DUST MASK
- WEAR EARPLUGS OR EARMUFFS AROUND NOISY EQUIPMENT
- STAY AWAY FROM FANS, DRIVE SHAFTS, AND FAN BELT ASSEMBLIES
- BEFORE ENTERING A FABRIC FILTER
  - -- CLEAN DUST FROM BAGS AND HOPPER
  - -- PURGE WITH AIR
  - -- BE SURE FAN IS "LOCKED OUT"
  - -- HAVE A SECOND TRAINED PERSON STANDING BY
  - -- PLAN TO STAY INSIDE AS SHORT A TIME AS POSSIBLE

SLIDE 11-16

FABRIC FILTERS: SAFETY PRECAUTIONS

DON'TS

- DO NOT PLACE HAND IN FAN BELT/PULLEY ASSEMBLY
- DO NOT CONTINUE TO OPERATE IF FAN IS VIBRATING SEVERELY
- NEVER ENTER FABRIC FILTER WITHOUT PROPER TRAINING AND EQUIPMENT

Slide 11-17

EMERGENCY PROCEDURES

- Post telephone numbers for emergency services
- Security should include incinerator on rounds
- Post spill control/decontamination procedures
- Post procedures for addressing puncture wounds

REFERENCES FOR SLIDES

References for Slides

Session 2

1. McRee, R. Operation and Maintenance of Controlled Air Incinerators. Ecolaire Environmental Control Products. Undated.

Session 3

1. Air Pollution Control District of Los Angeles County. Air Pollution Engineering Manual, 2nd Edition AP-40. (NTIS PB 225132). U. S. Environmental Protection Agency. May 1973.
2. Ecolaire Combustion Products, Inc. Technical Article: Principles of Controlled Air Incineration. Undated.
3. McRee, R. Operation and Maintenance of Controlled Air Incinerators. Ecolaire Environmental Control Products. Undated.
4. Consertherm Systems®. Technical Data Form for Rotary Kiln. Industronics, Inc. Undated.
5. Doucet, L. Waste Handling Systems and Equipment. Fire Protection Handbook, 16th edition. National Fire Protection Association.
6. Consumat Systems Inc. Technical Data Form for Waste Feed System. Undated.
7. U. S. Environmental Protection Agency. Source Category Survey: Industrial Incinerators. EPA 450/3-80-013. (NTIS PB 80-193303) May 1980.

Session 4

1. Joseph, J. and D. Beachler. APTI Course SI:412C, Wet Scrubber Plan Review Self-Instructional Guidebook. EPA 450/2-82-020. U. S. Environmental Protection Agency. March 1984.
2. U. S. Environmental Protection Agency. Control Techniques for Particulate Emissions from Stationary Sources, Volume 1. EPA 450/3-81-005a. (NTIS PB 83-127498) September 1982.
3. U. S. Environmental Protection Agency. APTI Course SI:412B, Electrostatic Precipitator Plan Review, Self-Instructional Guidebook. EPA 450/2-82-019. July 1983.

Session 5

1. Cleaver Brooks®. Operation, Maintenance, and Parts Manual for the Pyrolytic Incinerator. Publication No. CBK 6826. September 1988.

PART II.
STUDENT WORKSHEETS

WORKSHEET NO. 1

INCINERATOR SYSTEM INFORMATION

Can you describe the type incinerator you operate? Fill out this table. Circle the answer that best fits your system.

Operator's name ______________________________

Incinerator manufacturer ______________________________

A. Incinerator type (Circle)

1. Controlled ("starved") air
2. Multiple chamber "excess" air
   - In-line
   - Retort
3. Rotary kiln
4. Other
5. Don't know

B. My incinerator is designed especially for pathological waste:
Yes No Don't know

C. Operating mode

1. Single batch
2. Intermittent duty
3. Continuous duty
4. Don't know

D. Waste feed charge system

1. Manual - I do all the work
2. Mechanical hopper/ram
   a. Manually operated
   b. Automatic timer sequence
3. Mechanical hopper/ram with cart dumper
4. Other
5. Don't know

E. Ash removal system

1. Manual - rake and hoe
2. Continuous mechanical
3. Don't know

SW-2

INCINERATOR SYSTEM INFORMATION (CONTINUED)

F. Combustion Gas Flow

1. Natural draft
2. Induced draft
3. Balanced draft
   - Forced combustion air/natural draft stack
   - Forced combustion air/induced draft fan

G. Waste heat boiler

1. Yes
2. No

WORKSHEET NO. 2

INCINERATOR SYSTEM INFORMATION

Monitoring and Control Systems

Operator's name ______________________________

Incinerator manufacturer ______________________________

A. How would you describe the operating made of your incinerator?

1. Single batch
2. Intermittent duty
3. Continuous duty

B. How would you describe the control system used on your incinerator?

1. Manual
2. Automatic timer sequence
3. Automatic modulated control

C. What operating parameters are monitored or used as control parameters on your incinerator?

	Monitored	Function Controlled	Controlled
1. Primary Chamber Temperature			
2. Secondary Chamber Temperature			
3. Draft			
4. Charge rate			
5. Oxygen			
6. Carbon Monoxide			
7. Opacity			
8. Other:			

SW-4

WORKSHEET NO. 3

INCINERATOR SYSTEM INFORMATION

Operating Parameters

Operator's name ____________________

Incinerator manufacturer ____________________

What are the key operating parameters for your incinerator. What are the setpoints or operating ranges used?

Key Parameter	Setpoints/Operating Range		No setpoint
	upper	lower	
1. Primary chamber temperature			
2. Secondary chamber temperature			
3. Draft			
4. Charge rate			
5. Oxygen concentration			
6. Carbon monoxide concentration			

WORKSHEET NO. 4

OPERATING REVIEW

A. List the things to do when operating your incinerator that you think are the most important:

1.
2.
3.
4.
5.

B. Name the things to watch (monitor) when operating your incinerator that you think are the most important.

1.
2.
3.
4.
5.

C. Name the things not to do when operating your incinerator that your think are the most important:

1.
2.
3.
4.
5.

SW-6

WORKSHEET NO. 5

OPERATING PROBLEMS REVIEW

What are the most frequent problems you usually have?

A. **Problem:**

Possible causes:

Possible solutions:

B. **Problem:**

Possible causes:

Possible solutions:

C. **Problem:**

Possible causes:

Possible solutions:

SW-7

WORKSHEET NO. 6

INCINERATOR SYSTEM INFORMATION

Regulatory Limits

Operator's name ______________________________

Incinerator manufacturer ______________________________

What regulatory limits are you required to meet during operation of your incinerator?

Limit

A. Emission Limits:

1. Opacity
2. Particulate
3. Other

B. Operating Limits

1. Charge rate
2. Primary chamber temp
3. Secondary chamber temp
4. Oxygen concentration
5. Ash quality
6. Other

C. Record Keeping

1. Charge rate
2. Primary chamber temp
3. Secondary chamber temp
4. Other

SAFETY REVIEW

A. What personal safety gear do you use?

1. Coveralls
2. Hard soled shoes
3. Eye protection
4. Gloves
5. Dust mask
6. Ear protection

B. List the most serious safety hazards to which you are exposed. How do you minimize your chances of injury??

1.
2.
3.
4.
5.

PART C.

REFERENCES FOR SLIDES

References for Slides

Session 2

1. McRee, R. Operation and Maintenance of Controlled Air Incinerators. Ecolaire Environmental Control Products. Undated.

Session 3

1. Air Pollution Control District of Los Angeles County. Air Pollution Engineering Manual, 2nd Edition AP-40. (NTIS PB 225132). U. S. Environmental Protection Agency. May 1973.

2. Ecolaire Combustion Products, Inc. Technical Article: Principles of Controlled Air Incineration. Undated.

3. McRee, R. Operation and Maintenance of Controlled Air Incinerators. Ecolaire Environmental Control Products. Undated.

4. Consertherm Systems®. Technical Data Form for Rotary Kiln. Industronics, Inc. Undated.

5. Doucet, L. Waste Handling Systems and Equipment. Fire Protection Handbook, 16th edition. National Fire Protection Association.

6. Consertherm Systems®. Technical Data Form for Rotary Kiln. Industronics, Inc. Undated.

7. U. S. Environmental Protection Agency. Source Category Survey: Industrial Incinerators. EPA 450/3-80-013. (NTIS PB 80-193303) May 1980.

Session 4

1. Joseph, J. and D. Beachler. APTI Course SI:412C, Wet Scrubber Plan Review Self-Instructional Guidebook. EPA 450/2-82-020. U. S. Environmental Protection Agency. March 1984.

2. U. S. Environmental Protection Agency. Control Techniques for Particulate Emissions from Stationary Sources, Volume 1. EPA 450/3-81-005a. (NTIS PB 83-127498) September 1982.

3. Beachler, D. and M. Peterson. APTI Course SI:412A, Baghouse Plan Review Student Guidebook. EPA 450/2-82-005. U. S. Environmental Protection Agency . April 1982.

Session 5

1. Cleaver Brooks®. Operation, Maintenance, and Parts Manual for the Pyrolytic Incinerator. Publication No. CBK 6826. September 1988.

2. Jahnke, J. APTI Course SI:476A, Transmissometer Systems Operation and Maintenance, an Advanced Course. EPA 450/2-84-004. U. S. Environmental Protection Agency, Research Triangle Park, N.C. September 1984.

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1. McRee,, R. Operation and Maintenance of Controlled Incinerators. Ecolaire Environmental Control Products. Undated.

Session 9

1. U. S. Environmental Protection Agency. Workbook for Operators of Small Boilers and Incinerators. EPA 450/9-76-001. March 1976.